MODEL 7040
PCM SPAN—REPEATER TEST SET

INSTALLATION AND OPERATION

FOR REFERENCE ONLY

Northeast Electronics Instruction Manual
A7040-00-600 Issue 6 August 1983

northeast electronics
DIVISION OF tau-tron inc.
A UNIT OF GENERAL SIGNAL

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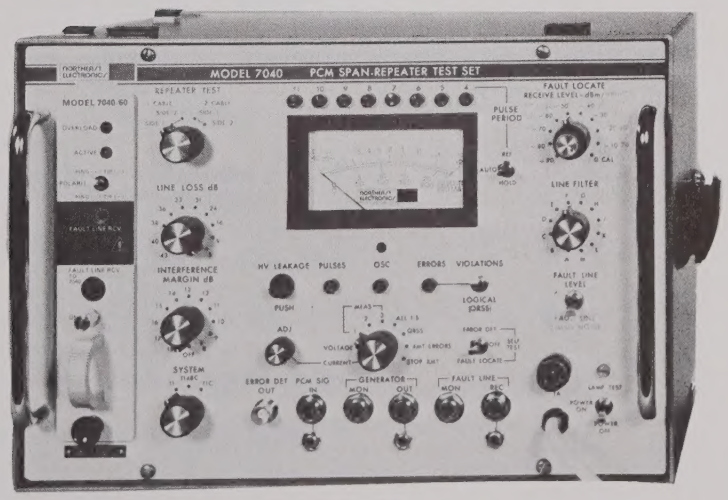

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SECTION 1

GENERAL DESCRIPTION

1.1 The Northeast Electronics Model 7040 is designed for central office testing/troubleshooting of PCM span lines and individual PCM repeaters. The 7040 is equipped with the features needed for:

- ☐ span line fault locating,
- ☐ span line performance testing . . . on an end-to-end or loop-back basis, and
- ☐ office and line repeater pre-installation/merit testing.

1.2 The 7040 has selectable send/receive bit rates compatible with T1 (1.544 Mbps), T148 (2.364 Mbps), and T1C (3.152 Mbps) PCM systems.

1.3 TRANSMIT CAPABILITIES

1.4 The Model 7040 generates the five most frequently needed test signal pulse patterns: QRSS (quasi-random) . . . All 1's (1111) . . . MEAS 1, 2, and 3. The QRSS and All 1's patterns are typically required by span line and repeater performance test practices. The QRSS pattern is a standard quasi-random word in which more than 20 successive zeros never occur but which accurately simulates the signals normally present in working PCM lines. The All 1's pattern has a pulse in every time slot.

1.5 The 7040 can transmit the QRSS pattern as an error-free signal, or as a signal into which errors have been deliberately introduced for convenient marking (identification) of a particular PCM line. When QRSS is used to test individual repeaters, the 7040 can insert known amounts of interfering signal to determine near-end-crosstalk (NEXT) and signal-to-noise (S/N) marginal limits.

1.6 The MEAS 1, 2, and 3 pulse patterns are typically required by span line fault locating practices and individual repeater test practices. MEAS 1 exercises both positive and negative pulse regeneration capabilities of repeaters. MEAS 2 and 3 help isolate repeater problems by allowing separate checking of positive and negative pulse regeneration capabilities.

1.7 The MEAS 1, 2, and 3 pulse patterns can be "modulated" by any of 12 standard audio frequencies (A through M) associated with the fault locating filters at repeater points along a span line. This permits selective identification of trouble sections on a line.

1.8 With the Model 7040, any of the 12 frequencies can be quickly and accurately selected by a single switch. No "fine tuning" is required for either send or receive.

1.9 Decreasing the pulse period (increasing density) of the MEAS 1, 2 or 3 patterns can be used to place greater operating stress on repeaters. This helps to identify marginal repeaters and other obscure troubles. With the Model 7040, pulse period can be stepped from: (a) 1 pulse group every 11 time slots to (b) 1 pulse group every 4 time slots. The stepping can be either manual or automatic. The automatic stepping is particularly convenient when gathering data for obscure trouble analysis charts defined in various span line fault locating practices.

1.10 RECEIVE CAPABILITIES

1.11 When performing span line fault locating tests, the Model 7040 measures the level (in dBm) of the audio interrogation tone received from a fault locating pair. The measured level is displayed on a front panel meter.

1.12 A C-message noise measuring feature is also built into the 7040 for convenience in evaluating fault locating line noise as required by many fault locating practices. Noise values (in dBrnC) are displayed on the front panel meter. A separate noise measuring set is not needed.

1.13 The 7040 is also equipped for monitoring active PCM lines carrying live traffic or test signals. It detects and indicates presence of pulses, bipolar violation errors (T1/T1C), disparity errors (T148C), 10-kHz line oscillations, and All 1's (1111) line oscillations. (The deliberate bipolar violations present in a T148C ternary-coded signal are ignored.)

1.14 In addition, the 7040 can detect and indicate any logical bit errors introduced into a QRSS test signal by PCM spans, repeaters, or other equipment. It performs 100 percent, bit-by-bit checking on the QRSS signal generated by its own transmitter or any other QRSS source such as the Northeast Electronics Model 7046. This capability is a helpful diagnostic tool and can be particularly significant when evaluating PCM lines used for data service.

1.15 ADDITIONAL CAPABILITIES

1.16 Adapter accessories allow the 7040 to test individual office and line repeaters of many types produced by many different manufacturers. The 7040 supplies correct dc power to the repeater under test and allows

1.45 If 10 kHz oscillation is present, only the OSC indicator will be lighted. If both the OSC and the PULSES indicators are lighted, the presence of All 1's oscillation is indicated. ERROR DET OUT BNC connector J1 allows a recording/counting device to be connected to the error detector output.

1.46 The audio or noise taken from a fault locate pair can be applied to the fault locate receiver through either a 310-type or a bantam-type jack labeled FAULT LINE REC. Note that a plug inserted into either of these jacks breaks the fault locate signal path from the repeater test function which can also supply the input. The FAULT LOCATE RECEIVE LEVEL (DBM/DBRNC) range switch inserts the appropriate amount of attenuation into the signal path ahead of the filters. Available noise ranges are 0 to 70 dBrnC; level ranges are − 90 to 0 dBm. When the FAULT LINE LEVEL/FAULT LINE C-MSG NOISE switch is in the FAULT LINE C-MSG NOISE position, the noise response is shaped by the C-message filter before being applied to the detector. For all positions of the function switch except CURRENT and VOLTAGE, the detector output is displayed on the meter.

1.47 To measure the fault locate signal level, the FAULT LINE LEVEL/FAULT LINE C-MSG NOISE switch is set to FAULT LINE LEVEL. The audio component of the fault locate signal is first applied to a highpass filter to remove any induced low-frequency power line hum. It is next applied to an audio filter that is tuned to the desired frequency by the fault locate receive tuning signal furnished by the transmit function. The filter has an extremely narrow bandpass, and only the audio frequency that was transmitted is passed on to the detector. The detector output is then displayed on the meter. A 310-type FAULT LINE MON jack is provided to monitor the fault line pair with a high-impedance device such as a headset or an oscilloscope.

1.48 A self test feature has been incorporated into the receive function. A self test signal furnished by the transmit function is applied to the SELF TEST switch. When the switch is set at ERROR DET, the error detector is exercised, and the indicators are lighted depending on the signal format selected. In the FAULT LOCATE position, all of the circuits in the fault locate receiver (except the C-message filter) are checked.

1.49 REPEATER TEST FUNCTIONS

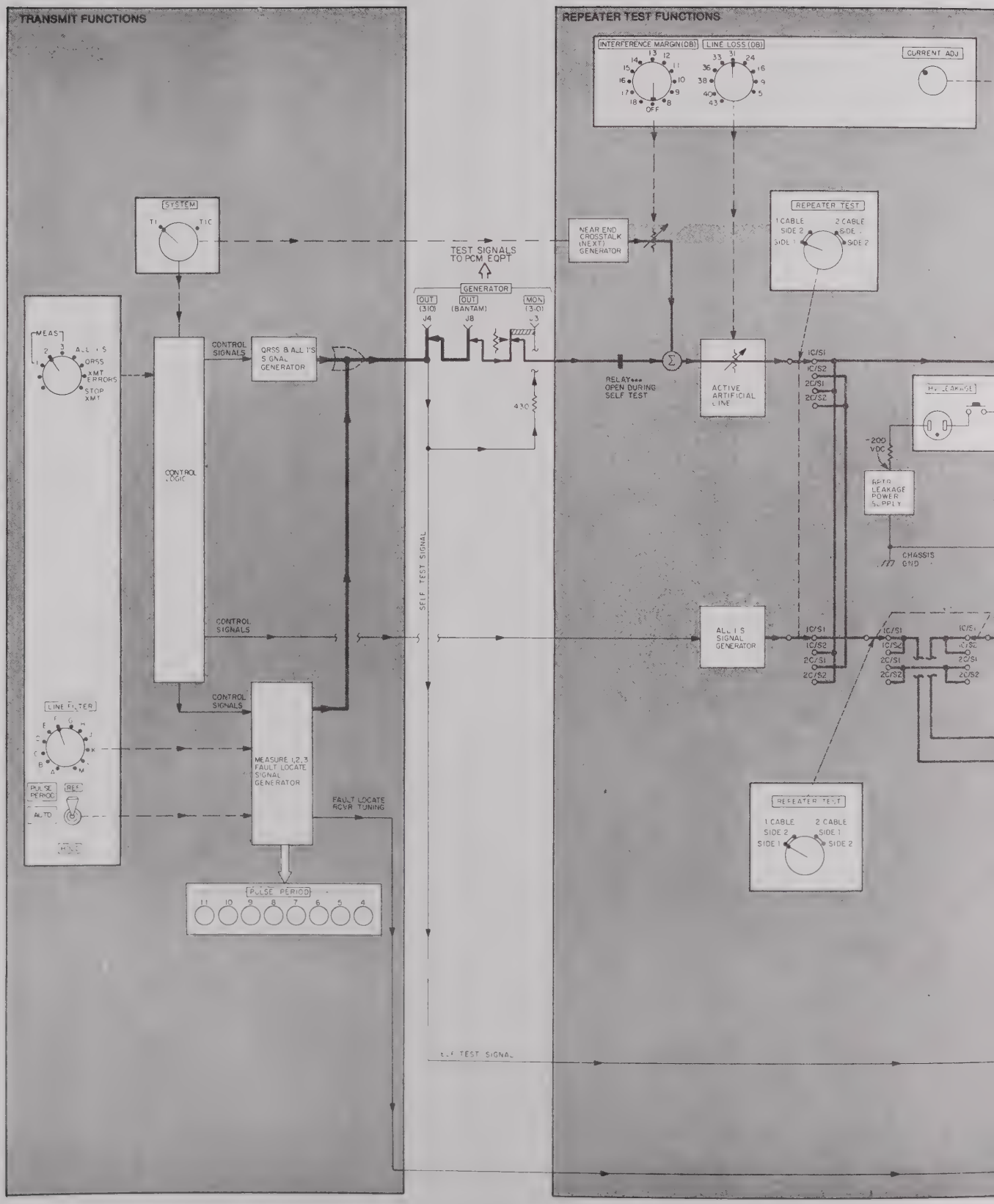
1.50 As shown in Figure 1−1, the repeater test function is situated between the transmit and receive functions and uses the series-connected access jacks for interconnection. Since the repeater tests rely on both of these functions, all jacks must be empty to perform repeater tests.

1.51 The repeater under test is inserted into the repeater test well which is designed to accept many types of repeaters through the use of adapters. After inserting the repeater under test into the adapter, the correct operating current must first be set. This is done by setting the function switch to the CURRENT position and then setting the CURRENT ADJ potentiometer to obtain the correct indication on the meter. Next the function switch is set to VOLTAGE to observe the voltage drop across the repeater. To check the leakage to repeater powering ground, − 200 V dc is connected through a resistor, a neon lamp, and a pushbutton switch to ground. When the pushbutton is closed, the neon lamp will light only if the insulation resistance (leakage) is below a specified limit.

1.52 Both 1-cable (bidirectional) and 2-cable (unidirectional) repeaters can be accommodated in the test arrangement. The five sections of the REPEATER TEST switch shown in Figure 1−1 route the signals into and out of the repeater in the correct directions when testing both sides 1 and 2. The side being tested is supplied any of the available signal formats from the transmitter function through an active artificial line. Under control of the LINE LOSS (DB) switch, the artificial line can simulate line losses within the range of 43 to 5 dB at T1 line bit rates. Whichever side of the repeater is not being tested is supplied an All 1's signal to keep its regenerator from oscillating.

1.53 The side of the repeater being tested is properly terminated in 100 ohms, and the signal is then applied to the error detector section of the receive function for pulses, errors, and oscillation checks. The fault locate pickoff winding is brought out and applied through a normally closed set of relay contacts before being sent to the fault locate receiver section of the receive function for the merit test. During self test, a resistor is placed across the input of the fault locate receiver through normally open relay contacts. This provides the correct termination for the self test signal source located in the transmitter function.

1.54 When measuring Near-End Crosstalk (NEXT), the output of the NEXT generator is summed with the signal from the transmitter function before being applied to the artificial line and then to the repeater under test. The INTERFERENCE MARGIN dB switch provides levels within the range of 18 to 8 dB below an All 1's signal.


TRANSMIT FUNCTIONS
REPEATER TEST FUNCTIONS
INTERFERENCE MARGIN (DB)
LINE LOSS (DB)
CURRENT ADJ
OFF
SYSTEM
T1
T1C
TEST SIGNALS TO PCM EQPT
NEAR END CROSSTALK (NEXT) GENERATOR
REPEATER TEST
1 CABLE SIDE 2 SIDE 1
2 CABLE SIDE 1 SIDE 2
GENERATOR
OUT (310) J4
OUT (BANTAM) J8
MON (310) J3
MEAS
ALL 1'S
QRSS
XMT ERRORS
STOP XMT
CONTROL SIGNALS
QRSS & ALL 1'S SIGNAL GENERATOR
CONTROL LOGIC
430
RELAYS OPEN DURING SELF TEST
ACTIVE ARTIFICIAL LINE
1C/S1
1C/S2
2C/S1
2C/S2
-200 VDC
REPEATER LEAKAGE POWER SUPPLY
CHASSIS GND
SELF TEST SIGNAL
ALL 1'S SIGNAL GENERATOR
LINE FILTER
PULSE PERIOD
REF
AUTO
MEASURE 1,2,3 FAULT LOCATE SIGNAL GENERATOR
FAULT LOCATE RCVR TUNING
PULSE PERIOD
11 10 9 8 7 6 5 4
SELF TEST SIGNAL

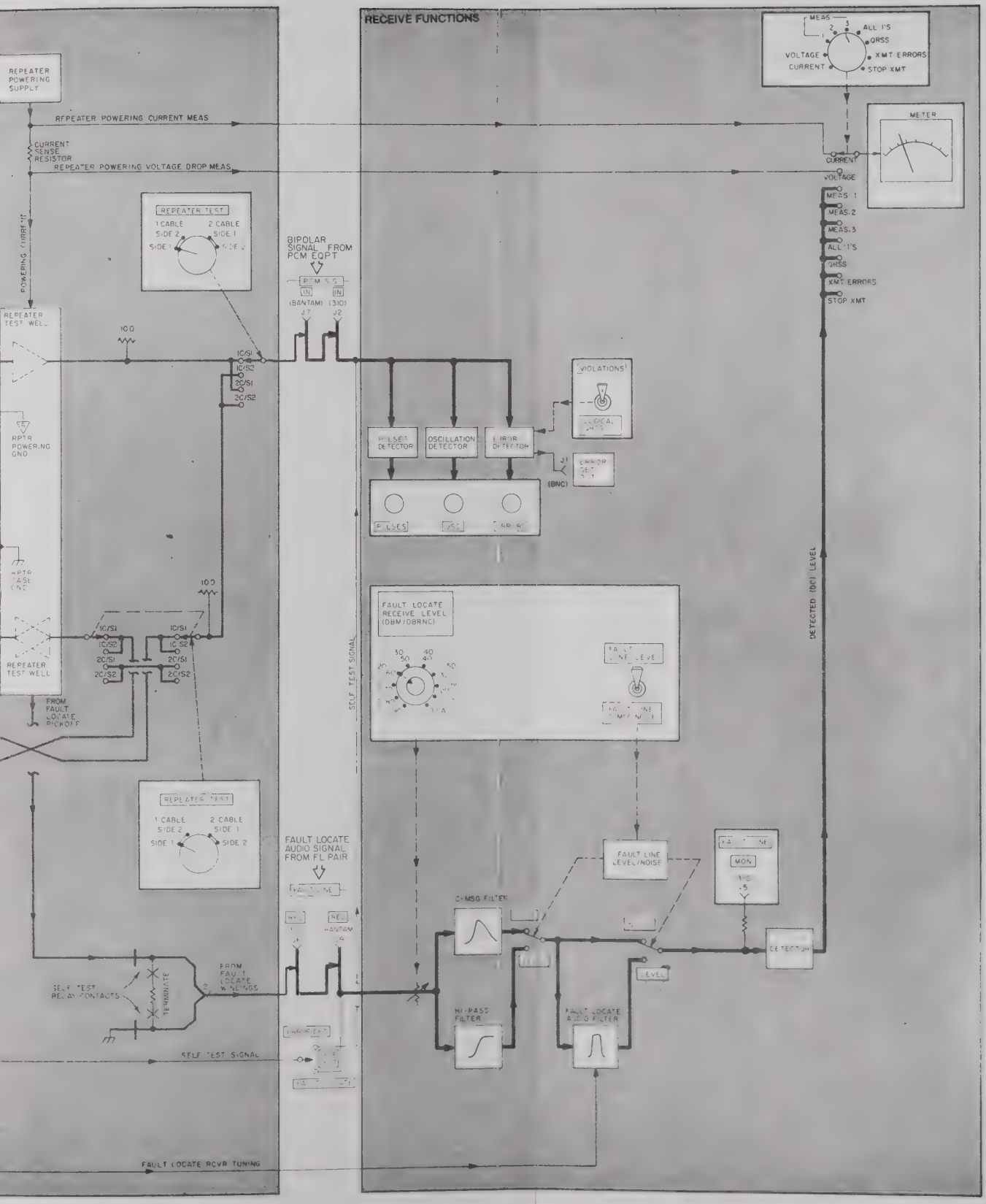


Figure 1-1. Model 7040 Functional Block Diagram

SECTION 2

SPECIFICATIONS

2.1 This section lists major specifications for the Model 7040 PCM Span-Repeater Test Set.

Table 2—1. Model 7040 Specifications.

TRANSMITTER	
Bit Rates	
T1	1.544 Mbps ± 50 ppm
T148C	2.364 Mbps ± 50 ppm
T1C	3.152 Mbps ± 30 ppm
Time Slots	
T1	648 nsec
T148C	423 nsec
T1C	317 nsec
Pulse Widths	
T1	324 nsec ± 10 %
T148C	211 nsec ± 10 %
T1C	160 nsec ± 10 %
Unbalance	less than ± 5 %
Maximum Rise/Fall Times	
T1	80 nsec
T148C	50 nsec
T1C	30 nsec
Pulse Amplitude	3 V ± 10 % base to peak
Trailing Edge Overshoot	10 to 30 % of pulse amplitude
Output Impedance	100 Ω ± 10 %, balanced
Selectable Pulse Patterns	
MEAS 1	Groups of positive and negative pulse trios that alternate at the selected audio rate

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Pulse Amplitude	3 V ± 10 % base to peak
Trailing Edge Overshoot	10 to 30 % of pulse amplitude
Output Impedance	100 Ω ± 10 %, balanced
Selectable Pulse Patterns	
MEAS 1	Groups of positive and negative pulse trios that alternate at the selected audio rate

Table 2—1. (Cont'd.)

TRANSMITTER (Cont'd.)	
MEAS 2	Groups of positive pulse trios and normal bipolar pulses that alternate at the selected audio rate
MEAS 3	Groups of negative pulse trios and normal bipolar pulses that alternate at the selected audio rate
All 1's	A logical 1 pulse is present in each time slot.
QRSS	The standard Bell System quasi-random signal source format. The word length is 1,048,575 bits with no more than 14 successive zeros in the T1 signal. The bit stream can be either error-free or can contain deliberate errors at the rate of one every ⅔ of a second. There is no zero suppression for T1C signal.
Fault Locating Frequencies	A = 832 Hz G = 1722 Hz B = 928 Hz H = 2008 Hz C = 1048 Hz J = 2193 Hz D = 1206 Hz K = 2413 Hz E = 1340 Hz L = 2860 Hz F = 1508 Hz M = 3017 Hz
Fault Locate Frequency Tolerance	All ± 0.5 %
Pulse Periods	11 to 4 selectable manually or automatically. In automatic mode, steps from pulse period 11 to pulse period 4, stopping at each pulse period for approximately 5 seconds.
Generator Monitor Jack Impedance	430 Ω resistors in series with the tip and ring
RECEIVER	
Fault Locating Parameters	
Receive Level Measure Sensivity	− 90 to 0 dBm full scale in 10-dB steps
Vernier Range	15 dB
C-Message Noise Range	0 to 70 dBrnC full scale in 10-dB steps
Level Reading Accuracy	± 1 dB at 0 dB on meter; ± 2 dB at − 10 dB on meter
Frequencies Detectable	Same as transmitter, filter selectivity of 1 ± 1 Hz centered at selected frequency
Input Impedance	900 Ω ± 10 %, balanced
Common Mode Rejection	60 dB min at 4 kHz
Fault Line Monitor Jack Impedance	10 kΩ

Table 2—1. (Cont'd.)

RECEIVER (Cont'd.)	
Error Detector Parameters	
Pulses	Flashes at a maximum rate of 10 per second to indicate the presence of pulses
Bipolar Violations	Flashes up to a maximum rate of 10 per second to indicate disparity errors
Logical Errors	Flashes once for each logical error found in bit-by-bit examination of QRSS signal; up to maximum of 10 per second
Oscillations	Flashes to indicate presence of 1 to 20 kHz (nominal 10 kHz) oscillations (squarewave), or All 1's oscillations
Input Impedance	200 Ω
Input Dynamic Range	0.3 to 3.3 V peak
Error Detector Output Jack	TTL compatible
REPEATER TEST PARAMETERS	
Powering Current	Adjustable from 50 to 220 mAdc
Meter Indications	
Current	0 to 220 mAdc
Repeater Voltage Drop	0 to 22 V dc
Meter Accuracy	± 5 % of full scale
Artificial Line	Provides selectable attenuation steps of 5, 9, 16, 24, 31, 33, 36, 38, 40, and 43 dB at 772 kHz
Interference (NEXT)	Sinewave level adjustable in 1 dB steps from 8 to 18 dB (± 0.5 dB) below level of All 1's signal at repeater input. T1 freq = 770 kHz, T1C freq = 1570 kHz, T148C freq = 1155 kHz. Tolerance = + 0, − 5 %
High Voltage Leakage Test	Applies 200 V dc ± 20 %; indicator lights when insulation resistance is less than 1 megohm ± 50 %
GENERAL	
Environmental	
Operating Temperature Range	0 °C to + 50 °C (32 °F to + 122 °F)
Storage Temperature Range	− 40 °C to + 75 °C (− 40 °F to + 167 °F).

Table 2—1. (Cont'd.)

GENERAL (Cont'd.)	
Relative Humidity	0 to 95 %, noncondensing
Power Requirements	115 V ac ± 10 %, 60 Hz, ± 10 %; approximately 30 watts
Size	13 in. w × 9 in. h × 11 in. d (33 cm × 22.9 cm × 27.9 cm)
Weight	Approximately 20 pounds (9.1 kg)

SECTION 3

INSTALLATION

3.1 The 7040 is a portable unit and requires no installation.

3.2 INITIAL INSPECTION

3.3 The unit is carefully inspected, both mechanically and electrically, before shipment. It should be free of defects and should be operating correctly when received. To confirm this, visually inspect the unit for signs of damage during shipment. If desired, the 7040's built-in self check and lamp test capabilities can be used to check operation (see Section 4 for procedures). If damage from transit is found, notify the common carrier immediately.

3.4 SERVICE INFORMATION

3.5 Complete warranty information is contained in the purchase order agreement under terms and conditions of sale. Summarized briefly, the Northeast Electronics warranty extends for a period of one year to the original purchaser of a Northeast test instrument. Northeast's system products are covered by a special warranty which can be summarized as follows.

- ☐ Hardware items are warranted for a period of 90 days.
- ☐ Software is warranted for a period of one year.

3.6 It is recommended that Northeast's Repair Department be contacted for assistance if, for any reason, a Northeast product fails to perform as expected. This step eliminates the needless delay entailed when a product is returned unnecessarily. Contact the Repair Department at Northeast Electronics, P.O. Box 2021, Concord, New Hampshire 03301, telephone (603) 228-3700.

3.7 If a Northeast Electronics product requires factory servicing **during** the warranty period, be sure to include a ship-to address and a description of the problem when returning the product to Northeast Electronics. **After** the warranty period has expired, equipment returned must be accompanied by all of the following:

- ☐ The number of the purchase order covering the cost of servicing,
- ☐ Bill-to address,
- ☐ Ship-to address, and
- ☐ Description of problem.

3.8 In all cases, equipment requiring factory servicing should be sent to the Repair Department at the preceding address and telephone number. A return material authorization (RMA) number is **not** required but will be provided by the Repair Department upon request.

3.9 To protect operating personnel, the National Electrical Manufacturers Association (NEMA) of the United States recommends that the front panel and cabinet be grounded. The Model 7040 is equipped with a three-conductor power cord which, when plugged into an appropriately grounded receptacle, will ground the panel and cabinet as recommended. The sleeves of all front panel jacks are also grounded via this connection.

SECTION 4

OPERATION

4.1 This section provides the instructions needed to test PCM span lines and their associated repeaters using the Model 7040 PCM Span-Repeater Test Set. These instructions include:

1. descriptions of operating controls, indicators, and jacks;

2. operational performance checks using the 7040's self test features;

3. span line performance test procedures using end-to-end and loop-back techniques;

4. span line fault locating procedures;

5. individual repeater test procedures; and

6. fault locating background information.

4.2 OPERATING CONTROLS, INDICATORS, AND JACKS

4.3 Figure 4—1 shows the 7040's controls, indicators, and jacks. Table 4—1 describes the functions of these items.

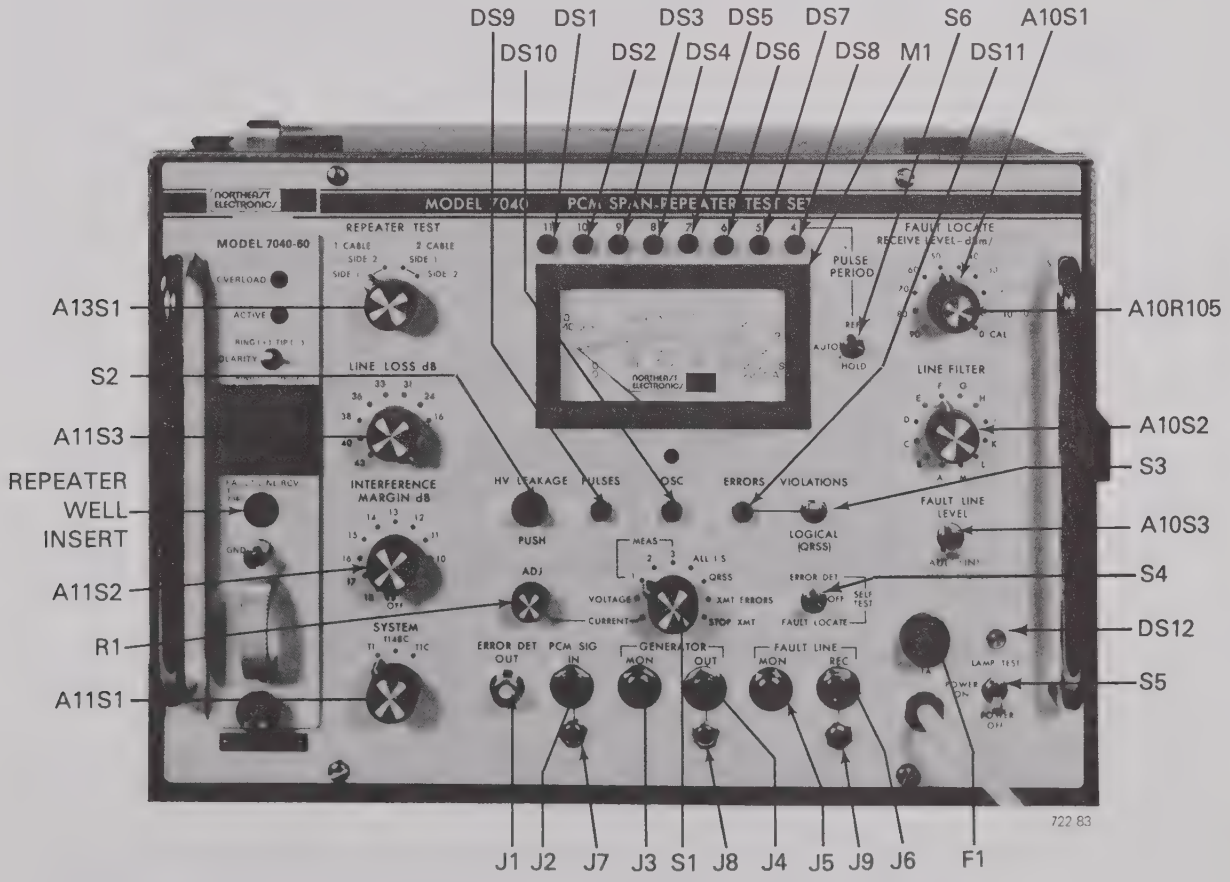

Table 4—1. Model 7040 Controls, Indicators, and Jacks.

REFERENCE DESIGNATION	CONTROL, INDICATOR OR JACK	FUNCTION
DS1-DS8	PULSE PERIOD indicators	When any one is lighted, it indicates the pulse density of a MEAS 1, 2, or 3 pattern being generated by the 7040. For example, when the 11 indicator (DS1) is lighted, the 7040 is producing a pattern with one pulse trio per 11 time slots.
DS9	PULSES indicator	When flashing, indicates presence of pulses at J2 or J7 or at the output of a repeater in the test well
DS10	OSC indicator	When flashing, indicates presence of nominal 10-kHz or All 1's oscillation at J2 or J7 or at the output of a repeater in the test well
DS11	ERRORS indicator	When flashing, indicates presence of either bipolar violation (T1/T1C) or disparity (T148) errors or QRSS logical errors at J2 or J7 or at the output of a repeater in the test well
DS12	Power indicator	When lighted, indicates that the 7040 is turned on
J1	ERROR DET OUT jack	A BNC connector for use in monitoring, recording, or counting all detected errors . . . either bipolar or logical. A TTL-compatible logic-low pulse appears at J1 for each detected errror.
J2 & J7	PCM SIG IN jacks	Type 310 and bantam jacks for use in monitoring a PCM span line for pulses, errors, and oscillations
J3	GENERATOR MON jack	A 310 jack for use in monitoring the 7040's PCM signal generator output. Tip and ring each have 430 Ω resistors in series for compatibility with office error detector.
J4 & J8	GENERATOR OUT jacks	Type 310 and bantam jacks for connecting the 7040's PCM generator output to a span line under test. The test signal pattern is controlled by S1.
J5	FAULT LOCATE MON jack	A 310 jack for use in monitoring the audio signal(s) present on a fault locating pair. Can be used with a high impedance headset or similar monitoring device.
J6 & J9	FAULT LINE REC jacks	Type 310 and bantam jacks for connecting the 7040 to a fault locating pair
M1	Meter	Indicates repeater powering current (mA), repeater voltage drop (V), audio fault locating tone level (dBm), or C-message noise (dBrnC) . . . depending on setting of switch S1 and type of test.
R1	CURRENT ADJ control	Sets operating current appropriately for a repeater in the test well. When S1 is at CURRENT position the repeater operating current is indicated on meter M1.

Table 4—1. (Cont'd.)

REFERENCE DESIGNATION	CONTROL, INDICATOR OR JACK	FUNCTION
S1	Function switch	Selects the function to be performed by the 7040 as follows: 1. CURRENT position selects measurement of powering current supplied to a repeater in the test well; current is shown on meter M1 and is adjustable via R1. 2. VOLTAGE position selects measurement of powering voltage drop across a repeater in the test well. 3. MEAS 1, 2, and 3 positions select corresponding measure pulse patterns for application to a span line or individual repeater under test. Audio modulating frequency for the measure patterns is selected by LINE FILTER switch A10S2. 4. ALL 1'S position selects an All 1's test signal pulse pattern for application to a span line or individual repeater under test. 5. QRSS position selects a quasi-random test signal pulse pattern for application to a span line or individual repeater under test. 6. XMT ERRORS position selects a QRSS pulse pattern into which deliberate errors are introduced about every ⅔ second. This corresponds to a bit error rate of 10^6 at a 1.544 Mbps clock rate. 7. STOP XMT position stops the 7040's generator output signal.
S2	HV LEAKAGE pushbutton/lamp	When pressed and held, applies 200 V dc between case and powering circuit ground of a repeater in the test well. This checks the insulation resistance. A lamp in the HV LEAKAGE pushbutton will light if insulation resistance is less than 1 megohm ± 50 %.
S3	VIOLATIONS/LOGICAL (QRSS) switch	1. VIOLATIONS position causes any detected bipolar violation errors (T1/T1C) or disparity errors (T148C) to appear as flashes of ERRORS indicator DS11. 2. LOGICAL (QRSS) position causes any logical errors detected in bit-by-bit checking of a T1 QRSS pattern to appear as flashes of ERRORS indicator S11.
S4	SELF TEST switch	1. OFF is normal position for regular use of the 7040; the self test feature is disabled. 2. ERROR DET position is used for self checking the 7040's error detection functions. 3. FAULT LOCATE position is used for self checking the 7040's circuits which monitor/measure the audio tones on a fault locating pair.

Table 4—1. (Cont'd.)

REFERENCE DESIGNATION	CONTROL, INDICATOR OR JACK	FUNCTION
S5	POWER/LAMP TEST switch	1. POWER OFF position removes ac input power from the 7040. 2. POWER ON position applies ac input power to the 7040. LED indicator DS12 should light. 3. LAMP TEST position checks front panel indicators DS1 through DS11. All these indicators should light.
S6	PULSE PERIOD REF/ AUTO/HOLD switch	Selects the stepping mode for pulse density variation when using MEAS 1, 2, or 3 test signal pulse patterns. 1. REF position fixes pulse period at 11. 2. AUTO position starts pulse period at 11 then automatically steps pulse period to 4. 3. HOLD position continuously holds pulse period at the number (11 through 4) which was present when the HOLD position was selected.
A10R105	Variable sensitivity control	When fully clockwise at CAL position, meter M1 shows absolute level (dBm) or noise (dBrnC) within the range selected by A10S1. Variable control can also be used to set meter at a reference level such as 0 for comparative measurements.
A10S1	FAULT LOCATE RECEIVE LEVEL dBm/dBrnC switch	The blue outer dBrnC scale sets sensitivity of the 7040's noise measuring receiver. The black inner dBm scale sets sensitivity of the 7040's level measuring receiver used for fault locating.
A10S2	LINE FILTER	Selects the fault locating filter code (frequency) to be used. This adds correct audio tone component to the 7040 generator's MEAS 1, 2, or 3 output and also conditions the 7040's receiver to "tune-in" only the selected audio frequency.
A10S3	FAULT LINE LEVEL/ FAULT LINE C-MSG NOISE switch	Selects either the level or noise measuring circuits of the 7040 to check a fault locating pair at J6/J9 . . . or a repeater in the test well.
A11S1	SYSTEM switch	Conditions the 7040 for testing at a T1 (1.544 Mbps), T148C (2.364 Mbps), or T1C (3.152 Mbps) bit rate.
A11S2	INTERFERENCE MARGIN dB switch	Selects an interfering signal amplitude (in dB below a nominal All 1's signal level) that is superimposed on the test signal applied to a repeater in the test well. This allows checking of repeater performance with near-end-crosstalk (NEXT) at the repeater input. The interfering signal is removed when the switch is at OFF position.

Table 4—1. (Cont'd.)

REFERENCE DESIGNATION	CONTROL, INDICATOR OR JACK	FUNCTION
A11S3	LINE LOSS dB switch	Selects the amount of artificial line loss (in dB) to be placed in series with a repeater in the test well. This simulates cable loss so that repeaters can be tested under realistic operating conditions.
A13S1	REPEATER TEST switch	Selects the correct electrical interface wiring to accommodate either 1 CABLE (bidirectional) or 2 CABLE (unidirectional) repeaters in the test well and also selects either SIDE 1 or SIDE 2 of a line repeater for testing.

4.4 OPERATIONAL PERFORMANCE CHECKS (SELF TESTS)

4.5 The 7040 has built-in features for:

1. checking its panel indicators (LAMP TEST);

2. checking its error detector circuits (ERROR DETECTOR SELF TEST); and

3. checking its fault locating audio tone measuring circuits (FAULT LOCATE SELF TEST).

4.6 LAMP TEST

4.7 The following paragraphs provide procedures which can be used for each of the three types of performance checks. To verify operational readiness of the indicators on the 7040 front panel, perform the following steps.

1. Plug 7040 power cord into 115 V ac 60 Hz power source.

2. Place POWER/LAMP TEST switch at POWER ON position.

3. The power indicator (DS12) should light.

4. Momentarily raise POWER/LAMP TEST switch to the LAMP TEST position. PULSE PERIOD indicators (1 through 4), PULSES, OSC, ERRORS indicators, and the indicator in the HV LEAKAGE pushbutton should all light.

5. Release POWER/LAMP TEST switch. This completes the lamp test.

4.8 ERROR DETECTOR SELF TEST

4.9 For this self test, the 7040's PCM generator output signal is internally routed (via SELF TEST switch) to the unit's error detection circuits. To verify operational readiness of the 7040's error detection circuits (and also portions of the PCM generator circuits), perform the following steps.

1. Plug 7040 power cord into a 115 V ac, 60 Hz power source.

2. Place POWER/LAMP TEST switch at POWER ON position.

NOTE

This self test can be performed at any time regardless of whether or not a repeater is in the test well. However, the self test indications are most unmistakable when a repeater is not installed in the well.

3. Make sure all front panel jacks are empty.

4. Set 7040 controls as follows:

   a. SYSTEM switch at T1,

   b. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS,

   c. PULSE PERIOD switch at REF, and

   d. Function switch (S1) at MEAS 1.

5. Raise SELF TEST switch to ERROR DET position and hold.

6. Observe the following front panel indications:

   a. PULSES indicator flashing rapidly,

   b. OSC indicator off, and

   c. ERRORS indicator flashing rapidly.

7. Continue holding SELF TEST switch at ERROR DET position while rotating function switch (S1) to MEAS 2 and MEAS 3.

8. Observe that front panel indications for MEAS 2 and MEAS 3 are the same as for MEAS 1, namely:

a. PULSES indicator flashing rapidly,

b. OSC indicator off, and

c. ERRORS indicator flashing rapidly.

9. Continue holding SELF TEST switch at ERROR DET and rotate function switch (S1) to All 1'S position.

10. Observe the following front panel indications:

a. PULSES indicator flashing rapidly,

b. OSC indicator flashing rapidly, and

c. ERRORS indicator off.

11. Continue holding SELF TEST switch at ERROR DET and rotate function switch (S1) to QRSS position.

12. Observe the following front panel indications:

a. PULSES indicator flashing rapidly,

b. OSC indicator off, and

c. ERRORS indicator off.

13. Continue holding SELF TEST switch at ERROR DET position and rotate function switch (S1) to XMT ERRORS position.

14. Observe the following front panel indications:

a. PULSES indicator flashing rapidly,

b. OSC indicator off, and

c. ERRORS indicator flashing slowly.

15. Continue holding SELF TEST switch at ERROR DET position and rotate function switch (S1) to STOP XMT position.

16. Observe the following front panel indications:

a. PULSES indicator off,

b. OSC indicator off, and

c. ERRORS indicator off.

17. Continue holding SELF TEST switch at ERROR DET and reposition the following controls:

a. SYSTEM switch at T1, T1C, or T148C,

b. VIOLATIONS/LOGICAL (QRSS) switch at LOGICAL (QRSS) position, and

c. Function switch (S1) at QRSS position.

18. Observe the following front panel indications:

a. PULSES indicator flashing rapidly,

b. OSC indicator off, and

c. ERRORS indicator off.

19. Continue holding SELF TEST switch at ERROR DET position and rotate function switch (S1) to XMT ERRORS position.

20. Observe the following front panel indications:

a. PULSES indicator flashing rapidly,

b. OSC indicator off, and

c. ERRORS indicator flashing slowly.

21. Release the SELF TEST switch. This completes the error detector circuit self test.

4.10 FAULT LOCATE SELF TEST

4.11 For this self test, the 7040's PCM generator output signal is internally routed (via SELF TEST switch) to the unit's fault locate pair monitoring/measuring circuits. To verify operational readiness of the 7040's fault locate pair monitoring/measuring circuits (and also portions of the PCM generator circuits), perform the following steps.

1. Plug 7040 into a source of 115 V ac, 60 Hz power.

2. Place POWER/LAMP TEST switch at POWER ON position.

NOTE

This self test can be performed at any time regardless of whether or not a repeater is in the test well. However, the self test indications are most unmistakable when a repeater is not installed in the well.

3. Make sure all front panel jacks are empty.

4. Set 7040 controls as follows:

   a. SYSTEM switch at T1,

   b. PULSE PERIOD switch at REF,

   c. Function switch (S1) at MEAS 1, and

   d. LINE FILTER switch at A, and

   e. FAULT LINE LEVEL/C-MSG NOISE switch at LEVEL.

5. Press SELF TEST switch to FAULT LOCATE position and hold.

6. Set RECEIVE LEVEL switch and adjust RECEIVE LEVEL vernier control (A10R105) to obtain a convenient reference meter reading below − 2 (such as − 5).

7. While observing meter, rotate LINE FILTER switch to positions B and then C. Note that meter reading increases at each position.

8. Move RECEIVE LEVEL switch to next highest range on black scale without disturbing the RECEIVE LEVEL vernier control (A10R105).

9. While observing meter, rotate LINE FILTER switch through all remaining positions to M. The meter reading should slowly increase. At LINE FILTER position M, the meter reading should be 12 ± 2 dB above the reference set at position A in step 6.

10. Place LINE FILTER switch at position F.

11. Set RECEIVE LEVEL switch and adjust RECEIVE LEVEL vernier control (A10R105) to obtain a convenient reference meter reading such as 0.

12. Place function switch (S1) at MEAS 2 position. The meter reading should drop 6 ± 1 dB. Remember the meter reading for the next step.

13. Place function switch (S1) at MEAS 3 position. The meter indication should be within ± 1 dB of that observed in step 12.

14. Place function switch (S1) back at MEAS 1.

15. Make sure meter reading is still at reference. If not, readjust RECEIVE LEVEL vernier (A10R105).

16. Place PULSE PERIOD switch at AUTO and observe a gradual rise as the 7040 cycles from pulse period 11 to pulse period 4. The meter should read no higher than + 2 dB when the cycling has reached pulse period 4.

17. Release SELF TEST switch. Return PULSE PERIOD switch to REF. This completes the fault locate self test.

4.12 IN-SERVICE TRANSMISSION MONITORING . . . USING 7040 AS AN OFFICE ERROR DETECTOR ON A WORKING SPAN LINE

4.13 The 7040 can be used to monitor a working span line for pulses, bipolar violations, disparity errors, and oscillations by connecting either of the 7040's PCM SIG IN jacks to the "monitor" jacks on the transmit or receive sections of an office repeater. To use the 7040 as an office error detector, perform the following steps.

1. Plug 7040 power cord into 115 V ac, 60 Hz source.

2. Place POWER/LAMP TEST switch at POWER ON.

3. Place SYSTEM switch at T1, T1C, or T148C as required.

NOTE

Patch cord should not be longer than six feet.

4. Connect a patch cord from appropriate repeater "monitor" jack to either of the 7040's PCM SIG IN jacks.

5. Place VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS.

6. A flashing PULSES indicator on the 7040 front panel displays presence of pulses.

NOTE

Some offices use automatic switching of spare span lines. The faulty line is supplied with an All 1's signal to prevent oscillation. This signal should not be mistaken for real All 1's oscillation.

7. A flashing OSC indicator **only** displays presence of 10 kHz oscillation. Flashing OSC **and** PULSES indicators display presence of All 1's oscillation.

8. A flashing ERRORS indicator displays presence of bipolar violation errors (T1/T1C) or disparity errors (T148C).

4.14 OUT-OF-SERVICE TRANSMISSION TESTING . . . END-TO-END SPAN LINE TESTING USING TWO 7040'S

4.15 Usually the first indication of trouble in a PCM system is a Carrier Group Alarm (CGA) or some other type of alarm triggered by an error rate detecting unit such as the Northeast Electronics Model 7010 T1 Line Scanning Monitor. When a CGA is registered, the trouble can be in either the transmitting terminal, the span line, an intermediate office, or the receiving terminal. When a trouble is detected by a 7010, the trouble can be in either the transmitting terminal, the intermediate office, or the span line.

4.16 The span line can be eliminated or confirmed as the source of trouble by removing the line from service and then testing it end-to-end. This can be accomplished by using one 7040 to send a good signal down the span line while monitoring the receive end for errors with a second 7040. The second 7040 also applies a signal to keep the other side of the span line from oscillating. See Figure 4—2. (A single 7040 can be used when the system is looped-back as described in paragraph 4.19.)

4.17 To test a span line end-to-end, perform the following steps.

1. At both ends, plug 7040 power cord into 115 V ac 60 Hz source and set controls as follows:

   a. Set POWER/LAMP TEST switch at POWER ON,

   b. Set SYSTEM switch at T1, T1C, or T148C as required, and

   c. Set function switch at QRSS.

2. At both ends, patch either of the 7040 GENERATOR OUT jacks to the L IN jack on the office repeater (or to any other appropriate access point).

3. At both ends, plug a 100 Ω termination resistor into the R OUT jack on the office repeater (or to any other appropriate access point).

NOTE

Patch cord should not be longer than six feet.

4. At office B, patch either of the 7040 PCM SIG IN jacks to the receive MON jack on the office repeater (or to any other appropriate access point).

5. At office B, set 7040 VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS.

CAUTION

Perform step 6 as rapidly as possible to keep the line from oscillating and interfering with other lines in use.

6. At office A, set 7040 function switch at STOP XMT. The PULSES indicator at office B should go out. If the indicator does not go out, the wrong line is being tested. Return the function switch to QRSS and investigate source of problem.

7. At office B, flashing PULSES indicator shows presence of pulses on the span line.

8. At office B, a flashing OSC indicator **only** displays the presence of 10 kHz oscillations. Flashing OSC and PULSES indicators **together** show the presence of All 1's oscillation.

9. At office B if ERRORS indicator is flashing, the presence of bipolar violations on T1/T1C or disparity errors on T148C is indicated.

10. At office A, set the 7040 function switch at ALL 1'S.

11. At office B, the PULSES and OSC indicators should be lighted.

4.18 The All 1's test signal is relatively easy for repeaters to regenerate since this signal contains a pulse in every time slot. In contrast, the QRSS test signal is more difficult for repeaters to handle since this signal has strings of successive zeros.

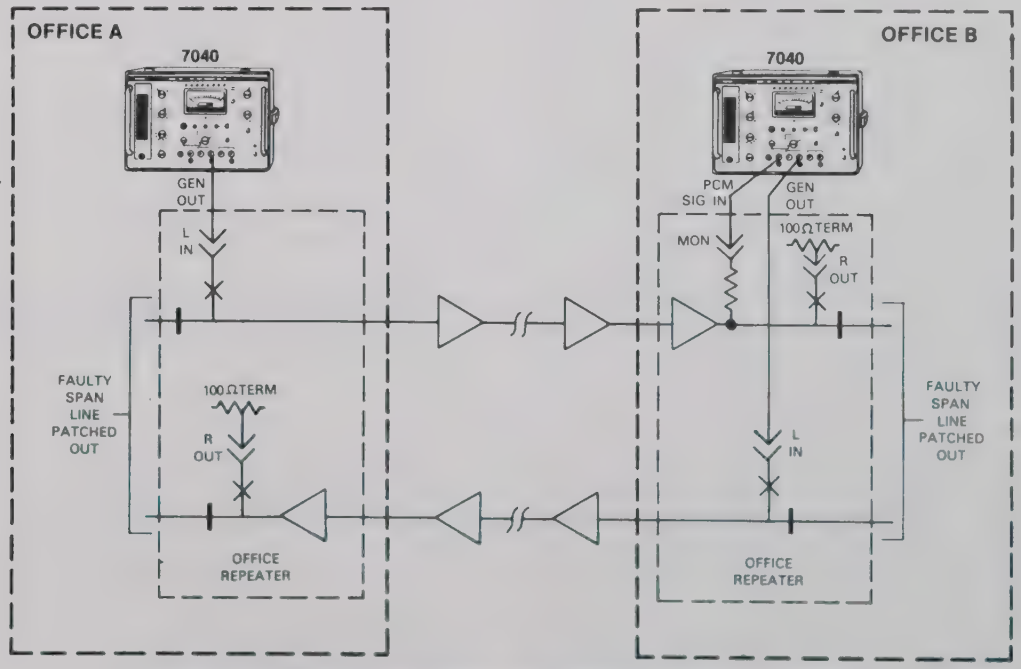

Figure 4—2. End-To-End Span Line Testing Using Two 7040's.

4.19 OUT-OF-SERVICE TRANSMISSION TESTING . . . LOOPED-BACK SPAN LINE TESTING USING A SINGLE 7040

4.20 A single 7040 can be used for testing if the second side of the span line is known to be operating properly. See Figure 4—3.

4.21 To use loop-back testing, perform the following steps.

1. Plug 7040 power cord into 115 V ac, 60 Hz source.

2. Set POWER/LAMP TEST switch at POWER ON position.

3. Set 7040's SYSTEM switch at T1, T1C, or T148C as required.

4. Set 7040's function switch at QRSS.

5. Set 7040's VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS.

6. At office A, patch either of the 7040 GENERATOR OUT jacks to the L IN jack on the office repeater (or to any other appropriate access point).

NOTE

Patch cord should not be longer than six feet.

7. At office A, patch either of the 7040 PCM SIG IN jacks to the receive MON jack on the office repeater (or any other appropriate access point).

8. At office A, plug a 100 Ω load into the R OUT jack on the office repeater (or any other appropriate access point).

9. At office B, patch the R OUT jack to the L IN jack on the office repeater. This loops the two sides of the span line at the office B end.

10. A flashing PULSES indicator displays presence of pulses on the span line under test.

11. A flashing OSC indicator **only** displays presence of nominal 10 kHz oscillations on span line. If **both** the OSC and PULSES indicators are flashing, the oscillations are All 1's.

12. If the ERRORS indicator is flashing, the presence of bipolar violations on T1/T1C or disparity errors on T148C is indicated.

13. Set function switch to All 1'S.

14. PULSES and OSC indicators should be flashing.

4.22 As noted previously, the All 1's signal is relatively easy for repeaters to regenerate since this signal contains a pulse in every time slot. In contrast, the QRSS test signal is more difficult for repeaters to handle since this signal has strings of successive zeros.

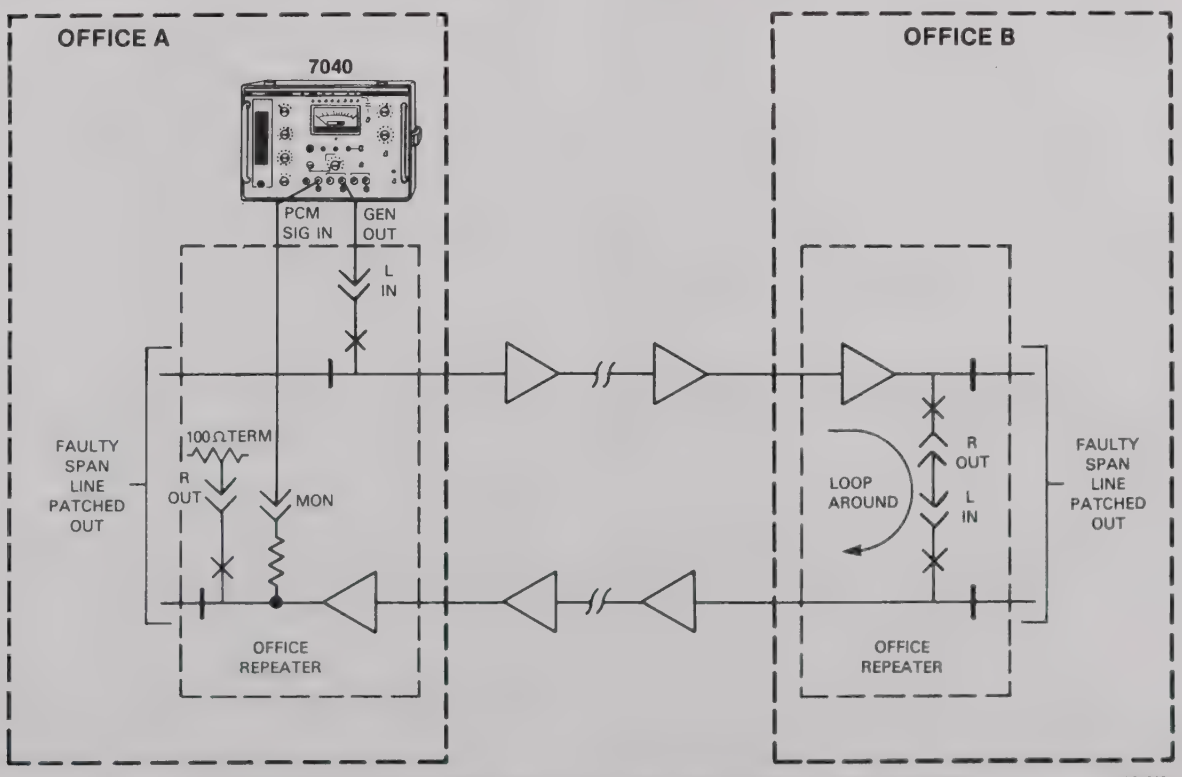

Figure 4—3. Looped-Back Span Line Testing Using a Single 7040.

4.23 USING THE 7040 TO CHECK FOR LOGICAL ERRORS

4.24 In many cases, the most meaningful test of a PCM system's quality involves: (1) transmission of a known test signal pattern through the system and (2) bit-by-bit checking of the pattern for logical errors at the receiving end. This type of test is particularly important when checking the performance of higher-order PCM carrier systems which may employ multiplexing, demultiplexing, digital radio transmission, and many other logical bit processing steps between a signal's source and destination.

4.25 The 7040 is equipped to generate the standard Bell System QRSS test signal pattern which has 1,048,575 bits per word and is limited to a maximum of 14 successive zeros. The 7040 is also equipped to receive this test signal pattern (from its own or any other standard T1 QRSS signal generator such as the Northeast Electronics Model 7046) and check the pattern bit-by-bit to detect any logical errors.

NOTE

The All 1's detector in the Model 7040 responds to unusually high density signals. Normal T1 traffic or a QRSS test signal does not trigger this detector. However, the PCM output of an unloaded or lightly loaded (less than 5 channel units) channel bank approaches the density of an All 1's signal and may trigger the All 1's detector. This should not be interpreted as a problem condition.

4.26 To use these 7040 capabilities and check for T1 logical errors, perform the following steps.

1. Plug 7040 at receiving location into a 115 V ac, 60 Hz power source.

2. Place POWER/LAMP TEST switch at POWER ON position.

3. At transmitting location, connect a T1 QRSS signal to the input of a circuit (or equipment) under test. A Model 7040 can supply the T1 QRSS signal. Connect to either of the GENERATOR OUT jacks on the 7040 and place the 7040's function switch at QRSS.

4. At the receiving location, apply a QRSS signal to the other side of the system to prevent oscillation (if required).

NOTE

Patch cord should not be longer than six feet.

5. At receiving location, patch the output of the circuit (or equipment) under test to either of the PCM SIG IN jacks on the 7040.

NOTE

The PCM SIG IN jack has an input impedance of 200 Ω and, as such, is **not** suitable for use as a bridging error detector. The input has been designed to be used with standard MON jacks having 430 Ω resistors.

6. Set the receiving 7040's controls as follows:

   a. SYSTEM switch at T1, T1C, or T148C,

   b. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS, and

   c. Function switch (S1) at QRSS.

7. A flashing PULSES indicator on the receiving 7040 shows the presence of pulses in the output signal from the circuit (or equipment) under test.

8. If ERRORS indicator is not flashing, set VIOLATIONS/LOGICAL (QRSS) switch at LOGICAL (QRSS). If ERRORS indicator now starts flashing, logical bit errors are present in the signal being monitored.

NOTE

On a circuit, logical bit errors are often the result of upstream bipolar violation errors being masked by processing through a multiplexer, demultiplexer, or similar unit.

4.27 FAULT LOCATING PROCEDURES

4.28 The following paragraphs contain fault locating test procedures for PCM transmission, obscure trouble testing (U.S.), and for evaluating results obtained from the obscure trouble test recording sheets. Also included is merit testing (Canada). For additional information on fault locating and the fault locating signal, refer to paragraphs 4.119 through 4.134.

4.29 FAULT LOCATING PAIR NOISE MEASUREMENT

4.30 Before actual fault locating, standard practices often require measurement of noise on the fault locating pair. See Figure 4—4. This is required so that excessive noise does not mask the true fault locating signal which may be at a very low level. **If the faulty span line has been removed from service, both sides of the span line must be supplied with a signal to prevent free-running oscillations.** For span lines with bidirectional repeaters, the signal can be looped back at the office repeater.

4.31 To measure the noise on a fault locating pair, perform the following steps.

1. At office A, place 7040 function switch (S1) at QRSS.

2. At office A, place 7040 SYSTEM switch at T1, T1C, or T148C as required.

3. At office A, plug 7040 power cord into 115 V ac, 60 Hz source.

4. At office A, place 7040 POWER/LAMP TEST switch at POWER ON position.

5. Remove the faulty span line from service.

6. At office A, patch either of the 7040's GENERATOR OUT jacks to span L IN jack. This applies a QRSS signal to the span line to prevent repeater oscillations.

7. At office B, patch R OUT jack to L IN jack on office repeater associated with faulty span line. (This loops the two sides of the span line at the office B end).

8. If there are any other idle span lines, apply some type of PCM signal to prevent oscillations.

9. At office A, make sure that the 7040 repeater test well is empty. (In some cases, oscillations from a repeater inadvertently left in the test well could interfere with the fault locating pair noise measurement.)

10. At office A, place the 7040 controls as follows:

    a. INTERFERENCE MARGIN switch at OFF,

    b. FAULT LINE LEVEL/C-MSG NOISE switch at C-MSG NOISE, and

    c. FAULT LOCATE RECEIVE LEVEL vernier control (A10R105) fully clockwise to CAL.

11. At office A, set FAULT LOCATE RECEIVE LEVEL switch to obtain an on-scale meter reading.

12. The absolute value of noise on the fault locating pair is a combination of the 7040 RECEIVE LEVEL switch setting (blue dBrnC scale) and the meter reading (blue dBrnC scale). Refer to appropriate practices and related documentation for information on allowable fault locating pair noise value. (A typical value is 14 dBrnC or less.)

NOTE

If the meter reading varies widely, there is probably an oscillating repeater somewhere on the span line under test (or on other span lines in the same cable). Recheck to ensure that all span lines are connected to a PCM signal source and that they are not oscillating. Then remeasure fault locating pair noise.

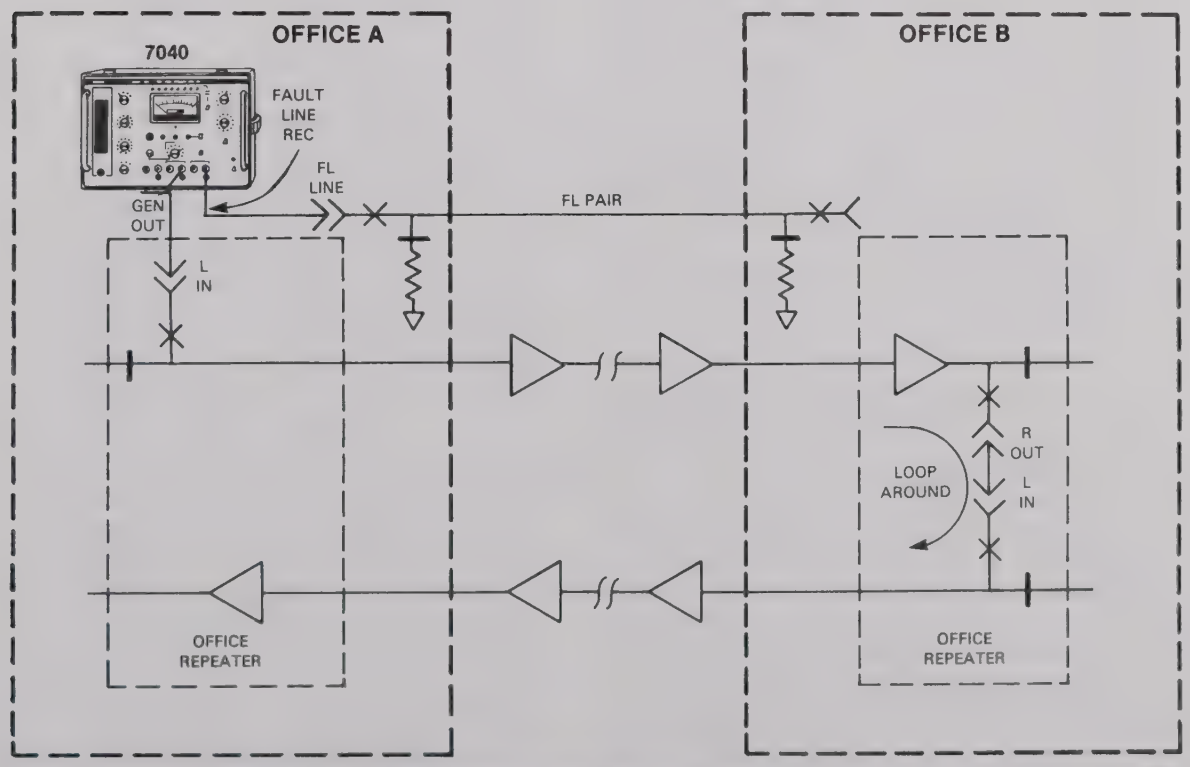

Figure 4—4. Typical Noise Measurement on Fault Locating Pair.

4.32 FAULT LOCATING PCM TRANSMISSION TEST

4.33 The fault locating plan allows a trouble on a span line to be isolated to a specific line section (filter code) between the output of one repeater and the output of the following repeater. The PCM transmission test is designed to reveal and locate total transmission failures or severely impaired transmission. If this test does not reveal the location of the problem, an obscure trouble test (described in paragraph 4.35) can be performed. Record all results on the PCM Fault Locating Record. (A typical sample of this type record is shown in Figure 4—11).

4.34 To locate a transmission failure, perform the following steps.

1. Remove faulty span line from service.

2. Measure the C-message noise on the fault locating pair as described in paragraph 4.29.

3. Apply PCM signal to idle side of span line under test and to all other idle span lines to prevent repeater oscillations.

4. Plug 7040 power cord into 115 V ac, 60 Hz source.

5. Set POWER/LAMP TEST switch at POWER ON position.

6. Patch either of the 7040's GENERATOR OUT jacks to span L IN jack on office repeater (or to any other appropriate span line access).

7. Patch of the 7040's FAULT LINE REC jacks to fault locate pair access jack.

8. Place 7040's controls as follows:

   a. SYSTEM switch at T1, T1C, or T148C as required,

   b. FAULT LINE LEVEL/C-MSG NOISE at LEVEL,

   c. PULSE PERIOD switch at REF,

   d. Function switch (S1) at MEAS 1,

   e. FAULT LOCATE RECEIVE LEVEL vernier (A10R105) fully clockwise at CAL, and

   f. INTERFERENCE MARGIN switch at OFF.

NOTE

Be sure that the 7040's repeater well is empty. (In some cases, oscillations from a repeater inadvertently left in the well might interfere with the fault locating measurement being made.

9. From office records, obtain fault locating filter codes for all repeaters on the faulty span line.

10. Set 7040 LINE FILTER switch at the filter code associated with the first repeater out of the office in direction of transmission.

11. Place 7040's FAULT LOCATE RECEIVE LEVEL switch at the − dBm range (black scale) which produces an on-scale meter reading. Record the measured level (combination of black RECEIVE LEVEL switch range and black dBm meter scale reading).

NOTE

It is helpful to select a RECEIVE LEVEL switch range that brings the meter indication closest to the 0 dB mark on the meter scale.

12. Place 7040's function switch at MEAS 2 position. Meter reading should drop about 6 dB (typical allowable tolerance = + 1.0 dB, − 1.5 dB). Record this level.

13. Place 7040's function switch at MEAS 3. Meter indication should be within ± 1 dB of the reading obtained in step 12.

14. Place 7040's function switch at QRSS position. Meter reading should drop at least 10 dB below the reading obtained in step 13.

15. Repeat steps 10 through 14 for all remaining repeaters on the faulty span line, proceeding in sequence away from the office in the direction of transmission.

16. If, after having completed the PCM transmission test on the entire span line there is no clear indication as to the faulty line section, more detailed testing is required. The traditional test performed in the U.S. is called an obscure trouble test and is presented in paragraphs 4.35 through 4.54. An alternative test method recently devised by Bell Northern Research of Canada is called a merit test and is described in paragraphs 4.55 through 4.58.

4.35 FAULT LOCATE OBSCURE TROUBLE TEST (U.S.)

4.36 The obscure trouble test is used to locate the more difficult-to-detect marginal operating conditions. This test should be performed only after the PCM transmission test (paragraph 4.32) fails to locate the trouble.

4.37 To test for obscure troubles, perform the following steps.

1. If not already completed, perform the fault locating PCM transmission test described in paragraph 4.32.

2. Ensure that the idle side of faulty span line is patched to a PCM signal source to prevent repeater oscillations.

3. Plug 7040 power cord into 115 V ac, 60 Hz source.

4. Set POWER/LAMP TEST switch at POWER ON position.

5. Patch either of the 7040's GENERATOR OUT jacks to span L IN jack of office repeater (or any other appropriate span line access jack).

6. Patch either of the 7040's FAULT LINE REC jacks to fault locate pair access jack.

7. Place 7040's controls as follows:

   a. SYSTEM switch at T1, T1C, or T148C as required,

   b. FAULT LINE LEVEL/C-MSG NOISE switch at LEVEL,

   c. PULSE PERIOD switch at REF,

   d. Function switch (S1) at MEAS 1,

   e. FAULT LOCATE RECEIVE LEVEL vernier (A10R105) fully clockwise to CAL, and

   f. INTERFERENCE MARGIN switch at OFF.

NOTE

Be sure that the 7040's repeater well is empty. (In some cases oscillations from a repeater in the well might interfere slightly with the fault locating measurement being made.)

8. From office records obtain fault locating filter codes for all repeaters on the faulty span line.

9. Set 7040's LINE FILTER switch at the filter code associated with the first repeater out of the office in direction of transmission.

10. Place 7040's FAULT LOCATE RECEIVE LEVEL switch at the – dBm range (black scale) needed to produce an on-scale meter reading.

NOTE

It is helpful to select the RECEIVE LEVEL switch range that brings the meter reading closest to the 0 dB mark on the meter scale.

11. Adjust RECEIVE LEVEL vernier (A10R105) to obtain a reading of exactly 0 dB on the meter.

12. Place PULSE PERIOD switch at AUTO.

13. As PULSE PERIOD indicators light in sequence from 11 to 4, record for each pulse period the deviation from 0 dB reference set in step 11.

NOTE

Typical practices employ the following data record-keeping rules.

a. If the deviation is ± 0.5 dB or less, record it as 0.

b. If the deviation is greater than ± 0.5 dB, record the exact deviation observed.

NOTE

A sample PCM Fault Locating Record form, typical of those employed in many United States practices, is provided as Figure 4–11.

14. If there is not enough time to record indications when using AUTO cycling, place the PULSE PERIOD switch at HOLD to stop cycling at each pulse period.

15. Repeat steps 9 through 14 for all remaining repeaters on the faulty span line, proceeding in sequence away from the office in direction of transmission.

16. To evaluate the recorded test data, refer to information presented under paragraph 4.38.

4.38 EVALUATION OF SPAN LINE OBSCURE TROUBLE TEST RECORDS (U.S.)

4.39 A span line can be comprised of:

1. All first-generation (fixed-LBO) repeaters,
2. All second-generation (ALBO) repeaters, or
3. A combination of both repeater types.

Different obscure trouble evaluation criteria are typically used for each of the three arrangements. Later paragraphs present typical test records and evaluation methods useful on the three arrangements.

4.40 **Evaluating Span Lines Comprised of All Fixed-LBO Repeaters (U.S.)**

4.41 As shown in Figure 4–5, the test record for a good span line comprised of all fixed-LBO repeaters and for a given line section (filter code) reveals a negative deviation from the reference level that increases in magnitude with decreasing pulse period number. It should also be observed that the increase in magnitude for a given line section is gradual and relatively uniform. The largest increase in magnitude usually occurs at pulse period 4 where the repeater is severely stressed. It is also important to note that the difference in magnitude at the stress points on adjacent line sections (rows) is small and relatively constant.

4.42 To evaluate the obscure trouble test record for a span line comprised of all fixed-LBO repeaters, perform the following steps.

1. Starting at the left of each row that represents a particular line section, mark the highest numbered pulse period that is not 0. (All deviations less than ± 0.5 dB should have been recorded as 0.) These marks represent the points of degraded performance or stress points for each repeater.

2. Scanning from top to bottom, observe each stress point mark and determine the row that shows the greatest increase in stress with respect to the previous row. This can be the greatest change in either deviation magnitude or pulse period number.

4.43 The important feature to look for is an abrupt change from the gradual and uniform variation associated with a good line. The row that shows this abrupt change usually identifies the faulty line section.

4.44 **Example.** Figure 4—6 shows a typical record for a faulty span line comprised of all fixed-LBO repeaters. Although there is only a 0.1 dB stress point magnitude difference in the deviation between filter codes D and E, the stress point jumped two pulse period numbers. This is a greater increase than between any other two codes. This points to possible trouble on the line section identified by filter code E.

4.45 Evaluating Span Lines Comprised of All ALBO Repeaters (U.S.)

4.46 As shown in Figure 4—7, the test record for a good span line comprised of all ALBO repeaters and for a given line section (filter code) reveals a positive deviation from the reference level that increases in magnitude with decreasing pulse period number. It should also be observed that the increase in magnitude for a given line section is gradual and relatively uniform. The largest increase in magnitude usually occurs at pulse period 4. It is also important to note that for a given pulse period number the deviations are relatively constant, showing a small decrease in magnitude. No stress points are shown.

4.47 To evaluate the obscure trouble test record for a span line comprised of all ALBO repeaters, perform the following steps.

1. Starting at the left of each row that represents a particular line section, mark the first numbered pulse period that fails to show an increase in deviation. (All deviations of ± 0.5 dB or less should have been recorded as 0.) These marks represent the points of degraded performance or stress points for each repeater.

2. Scan the rows from top to bottom and locate the first stress mark. This identifies the possible faulty line section.

4.48 **Example.** Figure 4—8 shows a typical record for a faulty span line comprised of all ALBO repeaters. The line section associated with filter code D contains the possible fault since this is the first line section to show a stress mark.

4.49 Evaluating Span Lines Comprised of Mixed Repeater Types (U.S.)

4.50 As shown in Figure 4—9, the test record for a good span line comprised of mixed repeaters reveals that each line section is representative of the repeater classification it contains. The fixed-LBO repeaters have a negative deviation from the reference that increases with decreasing pulse period number, while the ALBO repeaters show a positive deviation that increases with decreasing pulse period number. The largest increase for either type of repeater usually occurs at pulse period 4.

4.51 To evaluate the obscure trouble test record for a span line comprised of mixed repeaters, perform the following steps.

1. For all fixed-LBO repeaters, mark the first pulse period number (going from left to right) that is not 0.

2. For all ALBO repeaters, mark the first pulse period number (going from left to right) that fails to increase.

3. Scanning from top to bottom, observe each stress point mark and determine the row that shows the greatest increase in stress with respect to the previous row. This can be the greatest change in either deviation magnitude or pulse period number. The important feature to look for is an abrupt change. The row that shows this change usually identifies the faulty line section.

4.52 **Example.** Figure 4—10 shows a typical record for a faulty span line comprised of mixed repeaters. The suspected line section is D since it shows an increase of two pulse period numbers in stress point over the previous line section.

4.53 Reproducible Record Form for Obscure Trouble Test Data (U.S.)

4.54 Figure 4—11 is a blank record form typical of those used in United States practices for obscure trouble test data recording and evaluation. Additional copies of this form can be conveniently made by any offset printer or on office copying equipment.

FL FILTER CODE	RPTR TYPE	RPTR CLASS	TRANSMISSION TEST LEVEL (– dBm) AT PP11				OBSCURE TROUBLE TEST PULSE PERIOD NUMBER							
			MEAS 1	MEAS 2	MEAS 3	QRSS	11	10	9	8	7	6	5	4
A	201D	LBO	26.7	20.2	21.1	√	0	0	0	0	0	0	–0.7	–0.9
B	201D	LBO	26.2	21.7	20.8	√	0	0	0	0	0	0	–0.8	–1.0
C	201D	LBO	26.3	20.4	20.0	√	0	0	0	0	0	–0.6	–0.9	–1.2
D	201D	LBO	26.8	20.2	19.4	√	0	0	0	0	0	–0.8	–1.3	–1.5
E	201D	LBO	27.0	21.2	21.7	√	0	0	0	0	–0.7	–0.9	–1.6	–1.9
F	201D	LBO	27.8	22.0	21.6	√	0	0	0	0	–0.9	–1.0	–1.8	–2.3

◀ = HIGHEST PULSE PERIOD NUMBER WHERE STRESS BEGINS ON A LINE SECTION.

Figure 4—5. Typical U.S. Fault Locating Record for a Good Span Line Comprised of All Fixed-LBO Repeaters.

FL FILTER CODE	RPTR TYPE	RPTR CLASS	TRANSMISSION TEST LEVEL (– dBm) AT PP11				OBSCURE TROUBLE TEST PULSE PERIOD NUMBER							
			MEAS 1	MEAS 2	MEAS 3	QRSS	11	10	9	8	7	6	5	4
A	201D	LBO	26.7	20.2	21.1	√	0	0	0	0	0	0	–0.7	–0.9
B	201D	LBO	26.2	21.7	20.8	√	0	0	0	0	0	0	–0.8	–1.0
C	201D	LBO	26.3	20.4	20.0	√	0	0	0	0	0	–0.6	–0.9	–1.2
D	201D	LBO	26.8	20.2	19.4	√	0	0	0	0	0	–0.8	–1.3	–1.5
E	201D	LBO	27.0	21.2	21.7	√	0	0	0	–0.7	–0.8	–1.1	–1.9	–2.0
F	201D	LBO	27.8	22.0	21.6	√	0	0	0	–0.8	–1.1	–1.4	–2.1	–2.5

◀ = HIGHEST PULSE PERIOD NUMBER WHERE STRESS BEGINS ON A LINE SECTION

Figure 4—6. Typical U.S. Fault Locating Record for a Faulty Span Line Comprised of All Fixed-LBO Repeaters.

FL FILTER CODE	RPTR TYPE	RPTR CLASS	TRANSMISSION TEST LEVEL (– dBm) AT PP11				OBSCURE TROUBLE TEST PULSE PERIOD NUMBER							
			MEAS 1	MEAS 2	MEAS 3	QRSS	11	10	9	8	7	6	5	4
A	208B	ALBO	31.9	26.1	26.6	√	0	0	0	0	+0.7	+1.2	+1.7	+2.7
B	208B	ALBO	32.0	27.4	26.4	√	0	0	0	0	+0.7	+1.0	+1.5	+2.7
C	208B	ALBO	32.1	25.6	25.3	√	0	0	0	0	+0.7	+1.0	+1.4	+2.3
D	208B	ALBO	32.3	25.7	24.8	√	0	0	0	0	+0.7	+1.0	+1.5	+2.0
E	208B	ALBO	32.7	27.0	27.6	√	0	0	0	0	+0.6	+0.7	+1.2	+2.1
F	208B	ALBO	33.2	27.3	28.1	√	0	0	0	0	+0.5	+0.8	+1.0	+2.0

◀ = HIGHEST PULSE PERIOD NUMBER WHERE STRESS BEGINS ON A LINE SECTION

Figure 4—7. Typical U.S. Fault Locating Record for a Good Span Line Comprised of All ALBO Repeaters.

FL FILTER CODE	RPTR TYPE	RPTR CLASS	TRANSMISSION TEST LEVEL (– dBm) AT PP11				OBSCURE TROUBLE TEST PULSE PERIOD NUMBER							
			MEAS 1	MEAS 2	MEAS 3	QRSS	11	10	9	8	7	6	5	4
A	208B	ALBO	31.9	26.1	26.6	√	0	0	0	0	+0.7	+1.2	+1.7	+2.7
B	208B	ALBO	32.0	27.4	26.4	√	0	0	0	0	+0.7	+1.0	+1.5	2.7
C	208B	ALBO	32.1	25.6	25.3	√	0	0	0	0	+0.7	+1.0	+1.4	+2.3
D	208B	ALBO	32.3	25.7	24.8	√	0	0	0	0	+0.7	+0.9	+1.3	+1.1 ◀
E	208B	ALBO	32.7	27.0	27.6	√	0	0	0	0	+0.6	+0.7	+1.0	+0.6
F	208B	ALBO	33.2	27.3	28.1	√	0	0	0	0	+0.5	+0.8	+1.2	0

◀ = HIGHEST PULSE PERIOD NUMBER WHERE STRESS BEGINS ON A LINE SECTION

Figure 4—8. Typical U.S. Fault Locating Record for a Faulty Span Line Comprised of All ALBO Repeaters.

FL FILTER CODE	RPTR TYPE	RPTR CLASS	TRANSMISSION TEST LEVEL (− dBm) AT PP11				OBSCURE TROUBLE TEST PULSE PERIOD NUMBER							
			MEAS 1	MEAS 2	MEAS 3	QRSS	11	10	9	8	7	6	5	4
A	208A	ALBO	33.2	27.3	28.1	√	0	0	0	0	+0.7	+0.9	+1.3	◀ +1.1
B	208A	ALBO	32.7	27.0	27.6	√	0	0	0	0	+0.6	+0.9	+1.2	◀ +0.9
C	201D	LBO	32.3	25.7	24.8	√	0	0	0	0	0	0	◀ −0.6	+1.3
D	201D	LBO	32.1	25.6	25.3	√	0	0	0	0	0	◀ −0.6	−0.8	−2.8
E	208A	ALBO	32.0	27.4	26.4	√	0	0	0	0	0	+0.8	◀ +0.8	−0.1
F	208A	ALBO	31.9	26.1	26.6	√	0	0	0	0	0	+0.8	◀ +0.7	−0.5

◀ = HIGHEST PULSE PERIOD NUMBER WHERE STRESS BEGINS ON A LINE SECTION.

Figure 4—9. Typical U.S. Fault Locating Record for a Good Span Line Comprised of Mixed Repeater Types.

FL FILTER CODE	RPTR TYPE	RPTR CLASS	TRANSMISSION TEST LEVEL (− dBm) AT PP11				OBSCURE TROUBLE TEST PULSE PERIOD NUMBER							
			MEAS 1	MEAS 2	MEAS 3	QRSS	11	10	9	8	7	6	5	4
A	208A	ALBO	33.2	27.3	28.1	√	0	0	0	0	+0.7	+0.9	+1.3	◀ +1.1
B	208A	ALBO	32.7	27.0	27.6	√	0	0	0	0	+0.6	+0.9	+1.2	0.9
C	201D	LBO	32.3	25.7	24.8	√	0	0	0	0	0	0	◀ −0.6	−1.3
D	201D	LBO	32.1	25.6	25.3	√	0	0	0	0	◀ −0.7	−1.0	−1.5	−2.9
E	208A	ALBO	32.0	27.4	26.4	√	0	0	0	0	0	+0.6	◀ +0.4	−0.5
F	208A	ALBO	31.9	26.1	26.6	√	0	0	0	0	0	+0.6	◀ +0.2	−1.4

◀ = HIGHEST PULSE PERIOD NUMBER WHERE STRESS BEGINS ON A LINE SECTION

Figure 4—10. Typical U.S. Fault Locating Record for a Faulty Span Line Comprised of Mixed Repeater Types.

FL FILTER CODE	RPTR TYPE	RPTR CLASS	TRANSMISSION TEST LEVEL (-dBm) AT PP11				OBSCURE TROUBLE TEST PULSE PERIOD NUMBER									
			MEAS 1	MEAS 2	MEAS 3	QRSS	11	10	9	8	7	6	5	4		

◣ = HIGHEST PULSE PERIOD NUMBER WHERE STRESS BEGINS ON A LINE SECTION.

A01562

Figure 4—11. Sample PCM Fault Locating Record (U.S.).

4.55 FAULT LOCATING MERIT TEST (CANADA) (AN ALTERNATE METHOD)

4.56 Bell Northern Research (BNR) of Canada has devised an alternative fault locating test called a merit test. This test was developed to better handle the different characteristics observed when testing lines equipped with repeaters having the latest monolithic technology. Early field trial results using the test indicate that faulty repeaters are discovered with the same regularity as when using the traditional obscure trouble test. However, a significant improvement appears to be a reduction in the number of good repeaters incorrectly shown to be bad. This can significantly reduce the number of repeaters subjected to exhaustive, laboratory-type testing procedures.

4.57 The test still uses pulse period 11 as the reference point. **Its major change is that only the absolute difference between adjacent pulse period levels is recorded.** This is in contrast to the accumulative levels recorded in the traditional obscure trouble test. Another change is that slightly modified upper and lower limits have been set.

4.58 The fault locating merit test plan allows a trouble on a span line to be isolated to a specific line section (filter code) between the output of one repeater and the output of the following repeater. The PCM transmission test described in paragraphs 4.32, 4.33, and 4.34 should have been performed prior to this test. To perform the merit test, perform the following steps.

1. If not already completed, perform the fault locating PCM transmission test described in paragraphs 4.32, 4.33, and 4.34.

2. Ensure that the idle side of faulty span line is patched to a PCM signal source to prevent repeater oscillations.

3. Plug 7040 power cord into 115 V ac, 60 Hz source.

4. Set POWER/LAMP TEST switch at POWER ON.

5. Patch either of the 7040's GENERATOR OUT jacks to span L IN jack of office repeater (or to any other appropriate span line access jack).

6. Patch either of the 7040's FAULT LINE REC jacks to fault locate pair access jack.

7. Place 7040 controls as follows:

   a. SYSTEM switch at T1, T1C, or T148C as required,

   b. FAULT LINE LEVEL/C-MSG NOISE switch at LEVEL,

   c. PULSE PERIOD switch at REF,

   d. Function switch (S1) at MEAS 1,

   e. FAULT LOCATE RECEIVE LEVEL vernier (A10R105) fully clockwise at CAL, and

   f. INTERFERENCE MARGIN switch at OFF.

NOTE

Be sure that the 7040 repeater well is empty. (In some cases, oscillations from a repeater in the well might interfere slightly with the fault locating measurement being made.)

8. From office records, obtain fault locating filter codes for all repeaters on the faulty span line.

9. Set 7040 LINE FILTER switch at the filter code associated with the first repeater out of the office in direction of transmission.

10. Place 7040 FAULT LOCATE RECEIVE LEVEL switch at the − dBm range (black scale) needed to produce an on-scale reading.

11. Adjust RECEIVE LEVEL vernier (A10R105) to obtain a reading of exactly 0 dB on the meter.

12. Place PULSE PERIOD switch at AUTO.

13. As PULSE PERIOD indicators light in sequence from 11 to 4, record for each pulse period the deviation from the 0 dB reference. (Figure 4−12 can be reproduced and used as a typical record keeping chart.) If there is not enough time to record readings using auto cycling, set the PULSE PERIOD switch to HOLD at each of the pulse periods while taking data.

14. After all data has been collected, calculate the deviations between adjacent pulse periods starting with the difference between 11 and 10. Record all of this data in the DEV BTWN PERIOD columns. See Figure 4−13 for a partial example.

15. For deviations between pulse periods 11-10 to 6-5, the limits are − 0.4 dB to + 0.7 dB. For the deviation between pulse period 5-4, the limits are − 0.4 dB to + 1.0 dB. Repeaters that produce deviations outside of these limits should be considered suspect and subjected to further, more detailed testing.

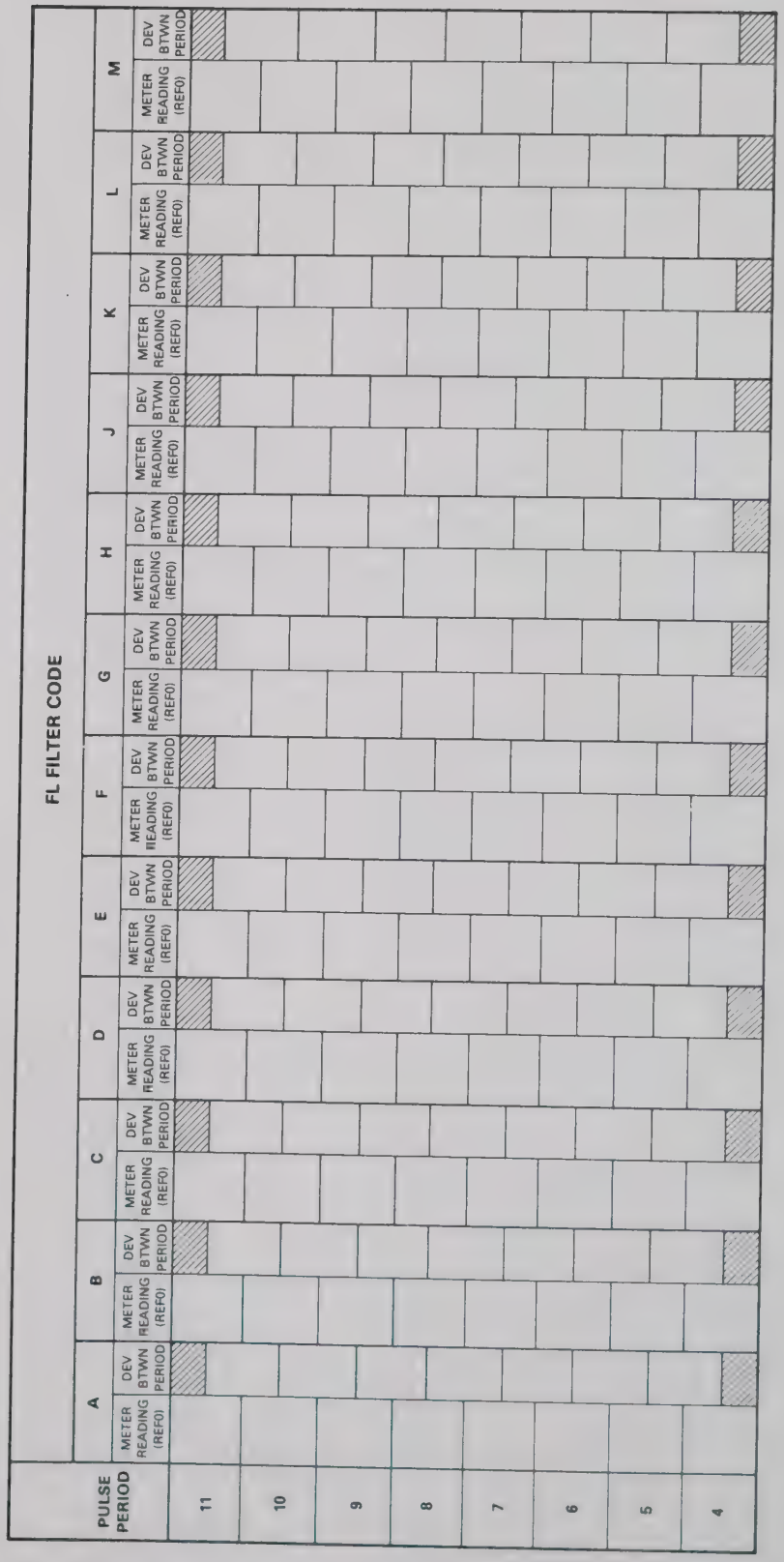

Figure 4—12. Sample Fault Locating Merit Test Data Record (Canada).

PULSE PERIOD	FL FILTER CODE A METER READING (REF0)	DEV BTWN PERIOD
11	0	
		+0.1
10	+0.1	
		+0.1
9	+0.2	
		+0.1
8	+0.3	
		+0.2
7	+0.5	
		+0.2
6	+0.7	
		+0.2
5	+0.9	
		0
4	+0.9	

B01839A

Figure 4—13. Partial Example of Merit Test Data.

4.59 INDIVIDUAL REPEATER TEST PROCEDURES

4.60 The 7040 is equipped to perform comprehensive testing of individual repeaters . . . both office and line types. This allows repeaters to be tested:

1. Before installation in a PCM system (preinstallation tests), or

2. After removal from a PCM system on suspicion of trouble (before committing the repeaters to repair).

4.61 A variety of different repeater test adapters (inserts) are used with the 7040 to handle repeaters of different sizes and types produced by different manufacturers. The adapters provide proper electrical and mechanical interfacing between the 7040 and the repeaters themselves. Table 4—2 lists the available adapters and the types of repeaters they handle.

4.62 Most adapters (particularly those for line repeaters) fit directly into the 7040 repeater test well. However, some adapters (particularly those for large office repeaters) are designed to attach on the left side of the 7040 case and connect to the test well via a plug-in assembly. Figure 4—14 shows how these larger adapters should be mounted on the 7040 and plugged into the repeater test well.

4.63 The 7040 can be used to independently test side 1 and side 2 of either 1-cable (bidirectional) or 2-cable (unidirectional) repeaters. The 7040 supplies a line repeater under test with line powering current which is adjustable from 50 to 220 mA. The powering current and the voltage drop across the line repeater can be monitored on the 7040 front panel meter. Office repeaters are supplied with their proper dc operating voltages.

4.64 A repeater plugged into the 7040 can be checked for insulation resistance (leakage) between the powering lead and case ground. Any of the 7040's test signals (QRSS . . . All 1's . . . MEAS 1, 2, 3) can be applied to the input of any repeater, and the repeater's output signal can be checked for pulses, oscillations, and errors.

4.65 A switch selectable artificial line in the 7040 simulates various lengths of actual cable so that repeaters can be tested under realistic operating conditions. Variable amounts of interference can be added to normal test signals so that a repeater's operating margin against interference (signal-to-noise ratio) can be checked. This later check is often called a near-end-crosstalk test (NEXT).

4.66 The 7040 can be used to test both ALBO and LBO repeaters. When LBO types are tested, they should have LBO networks installed to insure that oscillations will not be produced. LBO Code A networks are commonly used for test purposes, although other LBO codes can be used when desired.

4.67 Virtually any type of **line repeater** can be checked by using a general test procedure outlined in paragraph 4.69. All functions of a line repeater under test are exercised by the 7040 during this test procedure.

4.68 Testing of **office repeaters** is somewhat more individualized since many different powering arrangements are present in these repeaters. Procedures for setting up and testing different types of office repeaters are given starting at paragraph 4.83.

NOTE

It should be remembered that the 7040 is not equipped to test the span line powering circuits of certain office repeaters. Also the 7040 does not exercise the send side of these repeaters. Only the receive side is tested on the 7040.

Table 4—2. Alpha-Numeric Repeater Versus Adapter Listing.

MFR	MODEL/PN	SYSTEM	TYPE		CONFIG (CABLE)	PROTECTION	POWERING		ADAPTER
							I (MA)	DROP (V) @ (MA)	
General Electric	19C313627G1/2	T1	Line	ALBO	—	—	—	—	7040-50-900
	19C316986G1/2	T1	Line	ALBO	—	—	—	—	7040-50-900
	19D409497 Series	T1	Line	ALBO	½	—	85-220	11-12/140	7040-51-900
	19D422298 Series	T1	Line	ALBO	½	—	100-200	11.5-13/140	7040-50-900
	19D422326 Series	T1	Line	ALBO	—	—	100-200	11.5-13/140	7040-52-900
	19D422379G1/2	T1	Office	ALBO	—	—	—	—	7040-54-900
General Electric	19D422401 Series	T1	Line	ALBO	½	—	100-200	1.5-3/140	7040-51-900
GTE-Lenkurt	91080	T1	Line	LBO	1	no	120-220	10.4/140	7040-50-900
	91081	T1	Line	LBO	1	yes	120-220	12/140	7040-50-900
	91082	T1	Line	LBO	2	no	120-220	10.4/140	7040-50-900
	91083	T1	Line	LBO	2	yes	120-220	12/140	7040-50-900
	91110-01	T1	Line	ALBO	½	no	80-220	10/100	7040-50-900
	91111-01	T1	Line	ALBO	½	yes	80-220	11/100	7040-50-900
	91112	T1	Office	ALBO	—	—	—	—	none required
	91116-01/02	T1	Line	ALBO	½	—	80-220	10-11/100	7040-52-900
GTE-Lenkurt	91145 Series	T1C	Line	ALBO	½	—	—	7.8-8.2/135	7040-50-900
ITT	621240	T148C	Line	ALBO	½	yes	100-140	9.9-10.9/100 10.6-11.8/140	7040-52-900
Lynch	303RU01A	T1	Line	ALBO	½	no	60-200	9.1/140	7040-51-900
	303RU02A	T1	Line	ALBO	½	yes	60-200	10.7/140	7040-51-900
	303RU14	T1	Line	ALBO	½	yes	60-200	10.7/140	7040-52-900
	303RU15	T1	Line	ALBO	½	yes	60-200	10.7/140	7040-52-900
	303RU23	T1	Line	ALBO	½	no	60-200	9.1/140	7040-50-900
Lynch	303RU24	T1	Line	ALBO	½	yes	60-200	10.7/140	7040-50-900
Northern Telecom	QRY4A	T1	Line	ALBO	1	no	100/400	8.2/100	7040-57-900
	QRY4B	T1	Line	ALBO	2	no	100/140	8.2/100	7040-57-900
	QRY5A	T1	Line	ALBO	1	yes	100/140	9.4/100	7040-57-900
	QRY5B	T1	Line	ALBO	2	yes	100/140	9.4/100	7040-57-900
	QRY6A	T1	Office (pwr)	ALBO	—	—	100/140	—	7040-58-900
	QRY7A	T1	Office (no pwr)	ALBO	—	—	100/140	—	7040-58-900
	QRY8A	T1	Office (brdg)	ALBO	—	—	100/140	—	7040-58-900
	QRY9A	T1	Office (pwr)	ALBO	—	—	100/140	—	7040-54-900
	QRY10A	T1	Office (no pwr)	ALBO	—	—	100/140	—	7040-54-900
	QRY11A	T1	Office (brdg)	ALBO	—	—	100/140	—	7040-54-900
	201Q Series	T1	Line	LBO	—	no	140	—	7040-57-900
	205Q Series	T1	Line	LBO	—	yes	140	—	7040-57-900
Northern Telecom	206Q Series	T1	Office	LBO	—	—	140	—	7040-54-900

Note: At the time of publication the above list of repeaters represents those known to be compatible with the existing repeater adapters. For other repeaters, contact the Northeast Electronics Customer Service Department at (603) 228-3700.

Table 4—2. (Cont'd.)

MFR	MODEL/PN	SYSTEM	TYPE		CONFIG (CABLE)	PROTECTION	POWERING		ADAPTER
							I (MA)	DROP (V) @ (MA)	
RFL Types	–	T1	–	LBO	½	no	140	–	7040-50-900
Stromberg Carlson	965 Series	T1	Line	–	–	–	–	–	7040-52-900
Stromberg Carlson	975 Series	T1	Line	–	–	–	100	12.4/100	7040-52-900
Vicom	1280 Series	T1	Line	LBO	½	–	100-140	10.6-11.7/100	7040-52-900
Vicom	1550 Series	T1	Line	ALBO	½	–	100-140	10.7-12.2/100	7040-52-900
Wescom	3281	T1	Line	ALBO	–	–	75-200	–	7040-52-900
	3282	T1	Line	ALBO	–	–	75-200	–	7040-50-900
	3402 Series	T1	Office	ALBO	–	–	140	–	7040-54-900
	3440 Series	T1	Line	ALBO	½	–	100-200	11.3/140	7040-51-900
	3442 Series	T1	Line	ALBO	½	–	–	–	7040-52-900
Wescom	3443 Series	T1	Line	ALBO	½	–	–	–	7040-50-900
Western Electric	201 Series	T1	Line	both	½	no	100/140	–	7040-50-900
	205 Series	T1	Line	both	½	yes	100/140	–	7040-50-900
	206 Series	T1	Office	both	–	no	100/140	–	7040-54-900
	208 Series	T1	Line	ALBO	½	no	140	–	7040-51-900
	209 Series	T1	Line	ALBO	½	yes	140	12.2/140	7040-51-900
	218 Series	T1C	Line	ALBO	2	no	140	11/140	7040-53-900
	219 Series	T1C	Line	ALBO	2	yes	140	12.3/140	7040-53-900
	220 Series	T1C	Office	ALBO	–	no	140	–	7040-55-900
	238 Series	T1	Line	ALBO	½	no	60-200	6.8/60	7040-51-900
Western Electric	239 Series	T1	Line	ALBO	½	yes	60-200	7.5/60	7040-51-900

Note: At the time of publication the above list of repeaters represents those known to be compatible with the existing repeater adapters. For other repeaters, contact the Northeast Electronics Customer Service Department at (603) 228-3700.

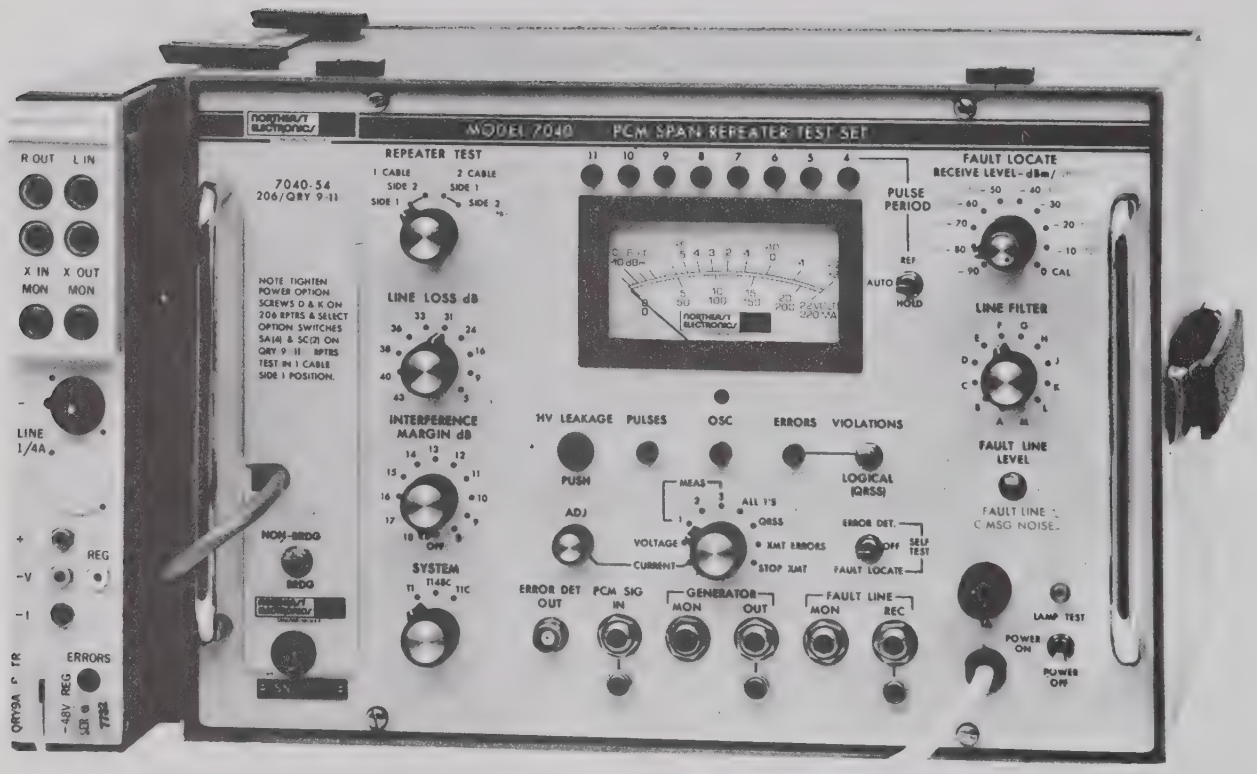

Figure 4—14. Mounting of Larger Repeater Test Adapters on the 7040 Case.

4.69 LINE REPEATER TEST PROCEDURE

4.70 The procedure in the following paragraphs exercises and tests an individual line repeater plugged into the 7040 test well. The repeater is checked for:

1. DC powering voltage drop at rated current,

2. Leakage resistance from powering lead to case ground,

3. Pulse, error, and oscillation performance,

4. Input dynamic range over varying signal amplitude and phase conditions that simulate lengths of actual cable,

5. Signal-to-noise ratio (near-end-crosstalk) performance margin, and

6. Positive/negative pulse regeneration balance.

4.71 A final merit test is then performed. This test employs the MEAS 1 signal, stepping from pulse period 11 to 4, to exercise the repeater under varying degrees of pulse density stress. The highest pulse densities (lowest pulse period numbers) used in this merit test are actually greater than a repeater normally encounters on an operating span line.

NOTE

During all of the above tests, the 7040 automatically supplies an All 1's PCM signal to the repeater side which is not being tested. This prevents oscillations on the side not under test.

4.72 To test individual line repeaters, perform the steps given in paragraphs 4.73 through 4.82.

4.73 **Line Repeater Pretest Set-Up**

1. Select the appropriate repeater well adapter from Table 4—2 and install the adapter in the 7040 test well.

2. If the repeater to be tested is an ALBO type, plug it directly into the test well adapter. If the repeater is an LBO type, make sure LBO networks are installed on both sides. (Code A networks are commonly used for testing.) Then plug the repeater into the test well adapter.

3. Make sure all 7040 front panel jacks are unplugged (empty).

4. Plug 7040 power cord into a 115 V ac, 60 Hz power source but do **not** turn the 7040 on yet.

5. Make the following initial control settings:

   a. SYSTEM switch as required (T1, etc.),

   b. REPEATER TEST switch as required (1 CABLE/ SIDE 1, etc.)

   c. INTERFERENCE MARGIN switch at OFF,

   d. PULSE PERIOD switch at REF, and

   e. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS.

6. Proceed to the powering current/voltage test of paragraph 4.74 which follows.

NOTE

The 7040 senses whether the repeater is strapped for "looped" or "thru" powering. The 7040 automatically supplies the correct powering conditions.

4.74 Line Repeater Powering Current/Voltage Test

1. Turn 7040 CURRENT ADJ control fully counterclockwise (CCW).

2. Set 7040 function switch at CURRENT.

3. From manufacturer's data or other records, determine the repeater's proper operating current.

4. Set POWER/LAMP TEST switch at POWER ON. This energizes the 7040 test set.

5. Turn CURRENT ADJ control to obtain proper repeater operating current reading on the meter.

6. Place function switch at VOLTAGE. The meter now shows voltage drop across the repeater. The voltage should be within tolerances specified by the repeater manufacturer.

7. Proceed to the leakage check of paragraph 4.75 which follows.

4.75 Line Repeater HV Leakage Check

1. Press and hold the HV LEAKAGE pushbutton.

2. Indicator lamp inside the pushbutton should **not** light. If it does light, there is excessive leakage between the repeater's powering leads and the repeater case.

3. Release the button and proceed to the pulses, errors, and oscillations test of paragraph 4.76 which follows.

4.76 Line Repeater Pulses, Errors, and Oscillations Test

1. Verify that the 7040 controls are set as follows:

   a. INTERFERENCE MARGIN switch at OFF,

   b. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS, and

   c. PULSE PERIOD switch at REF.

2. Set LINE LOSS switch as follows:

   a. For ALBO repeaters, set at 31 dB, and

   b. For LBO repeaters, set according to LBO network installed on side under test and the corresponding switch setting listed in Table 4—3.

NOTE

The LINE LOSS switch is calibrated in dB for T1 systems. See Table 4—4 for (a) corresponding cable feet equivalents and (b) corresponding dB values referenced for T148C and T1C systems.

3. Set 7040 function switch at QRSS.

NOTE

The repeater side not under test automatically receives an All 1's signal from the test set to prevent oscillations on that side.

4. If the repeater is operating correctly, the following indications should be observed:

   a. PULSES indicator flashing rapidly,

   b. OSC indicator off, and

   c. ERRORS indicator off.

NOTE

If PULSES indicator is not flashing (or is flashing intermittently), the repeater is not properly handling the test signal. If OSC indicator **only** is flashing, the repeater output contains nominal 10-kHz oscillations. If PULSES and OSC indicators are **both** flashing, All 1's oscillation is indicated. If ERRORS indicator is flashing, the repeater is producing bipolar violations (T1/T1C) or disparity errors (T148C).

NOTE

If desired, the repeater's operation may be checked over its specified powering current range. Set 7040 function switch at CURRENT. This applies a QRSS signal to the repeater while allowing the powering current to be adjusted and monitored. Rotate CURRENT ADJ control for meter indication over the repeater's specified range. The repeater should produce no ERRORS over this range. Return CURRENT ADJ to nominal value and continue with the repeater test procedure.

5. Set function switch at XMT ERRORS.

6. If repeater is operating correctly, the following indications should be observed:

a. PULSES indicator flashing rapidly,

b. OSC indicator off, and

c. ERRORS indicator flashing slowly.

7. Return function switch to QRSS position.

8. Place VIOLATIONS/LOGICAL (QRSS) switch at LOGICAL (QRSS).

9. Place SYSTEM switch to T1, T1C, or T148C.

10. If repeater is operating correctly, the following indications should be observed:

a. PULSES indicator flashing rapidly,

b. OSC indicator off, and

c. ERRORS indicator off.

NOTE

If ERRORS indicator flashes, the repeater is creating logical bit errors as it handles the T1 QRSS signal. If repeater displayed violation errors in step 4 above, then the logical error check will also show errors.

11. Return VIOLATIONS/LOGICAL (QRSS) switch to VIOLATIONS.

12. Proceed to the dynamic range test of paragraph 4.77 which follows.

Table 4—3. LBO Network Information

LBO CODE	NOMINAL LINE LOSS FOR WHICH INTENDED (DB)	7040 LINE LOSS TEST SWITCH SETTING (DB)
A5	43.0	43
A4	40.6	40
A3	38.2	38
A2	35.8	36
A1	33.4	33
A	31.0	31
B	28.6	31
C	26.2	31
D	23.8	24
E	21.4	24
F	19.0	24
G	16.6	16
H	14.2	16
J	11.8	16
K	9.4	9
L	7.0	9
M	4.6	5

Table 4—4. LINE LOSS Switch Versus Cable/Loss Equivalents.

LINE LOSS SWITCH POSITION (DB)	APPROX. ARTLINE CABLE FEET EQUIV* (KFT)	T1 LOSS* (DB)	T148C LOSS* (DB)	T1C LOSS* (DB)
43	9.7	43.0	54.8	63.7
40	9.0	40.0	51.0	59.3
38	8.5	38.0	48.4	56.3
36	8.1	36.0	45.9	53.4
33	7.4	33.0	42.0	48.9
31	6.5	31.0	39.5	45.9
24	5.0	24.0	30.6	35.6
16	3.3	16.0	20.4	23.7
9	1.9	9.0	11.5	13.3
5	1.0	5.0	6.4	7.4

*NOTES: The precision artificial line in the test set is computer-designed and optimized to represent the best average between the characteristics of PIC (paper) and PULP cable. T1 loss values are referenced to 772 kHz. T148C loss figures are referenced to 1.182 MHz. T1C loss figures are referenced to 1.575 MHz.

4.77 **Line Repeater Input Dynamic Range Test**

1. With function switch in QRSS position, rotate LINE LOSS switch slowly clockwise and counterclockwise to determine the switch settings at which the ERRORS indicator just starts to flash. Refer to manufacturer's specifications for the acceptable LINE LOSS range of repeater under test.

NOTE

A typical LINE LOSS range for LBO repeaters (with Code A LBO networks installed) is 24 to 36 dB. ALBO repeaters typically operate over a LINE LOSS range of 5 to 35 dB.

2. Proceed to the interference margin test of paragraph 4.78 which follows.

4.78 **Line Repeater Interference Margin Test**

1. Set LINE LOSS switch as follows:

   a. for ALBO repeaters, set at 31 dB, and

   b. for LBO repeaters, set according to the LBO network on side under test and the information in Table 4—3.

2. With function switch in QRSS position, rotate INTERFERENCE MARGIN switch slowly clockwise until ERRORS indicator just starts to flash. The INTERFERENCE MARGIN switch setting at this point represents the interfering signal margin (signal-to-noise ratio) capability of the repeater under test. Refer to manufacturer's wideband signal-to-noise ratio specifications for the repeater to determine if requirements are being met.

NOTE

For many repeater models, the acceptable interference margin will lie between 12 and 8 dB.

3. Return the INTERFERENCE MARGIN switch to OFF.

4. Proceed to the fault locate output and positive/negative pulse balance test of paragraph 4.79 which follows.

4.79 **Line Repeater Fault Locate Output and Pos/Neg Pulse Regeneration Balance Test**

1. Set 7040 controls as follows:

   a. LINE FILTER switch at F,

   b. FAULT LINE switch at LEVEL, and

   c. RECEIVE LEVEL vernier fully clockwise at CAL.

2. Verify that other controls are still set as follows:

   a. LINE LOSS switch at 31 dB for ALBO repeater, or according to Table 4—3 for LBO repeater,

   b. INTERFERENCE MARGIN switch at OFF, and

   c. PULSE PERIOD switch at REF.

3. Set function switch at MEAS 1.

NOTE

When using MEAS 1, 2, or 3 test signals, ERRORS indicator is lighted. This is normal.

4. Set RECEIVE LEVEL range switch (normally − 70) for an on-scale meter reading. Note the reading in dBm (black scales) and refer to manufacturer's specifications for acceptable performance.

NOTE

For many repeater types, the acceptable fault locate signal output under these test conditions is − 75 ± 5 dBm.

5. Set RECEIVE LEVEL range switch **and** vernier to obtain a meter reading of exactly 0 dB (black scale).

NOTE

When using MEAS 1, 2, or 3 test signals, the ERRORS indicator is flashing. This is normal.

6. Move function switch to MEAS 2. Meter reading should drop by 6 ± 1 dB. Remember reading for next step.

7. Move function switch to MEAS 3. Meter should read within ± 1 dB of step 6.

8. Return function switch to MEAS 1.

9. If repeater is an LBO type, proceed to step 10. If repeater is an ALBO type, repeat steps 3 through 7 at LINE LOSS switch settings of 9 and 16 dB. Then return LINE LOSS switch to 31 dB and proceed to step 10.

10. Proceed to the merit test of paragraph 4.80 which follows.

4.80 Line Repeater Merit Test

1. Verify that controls are in the following positions:

NOTE

When using MEAS 1, 2, or 3 test signals, the ERRORS indicator is flashing. This is normal.

a. Function switch at MEAS 1,

b. LINE FILTER switch at F,

c. LINE LOSS switch at 31 dB for ALBO repeaters or according to Table 4−3 for LBO repeaters,

d. INTERFERENCE MARGIN switch at OFF,

e. PULSE PERIOD switch at REF, and

f. FAULT LINE switch at LEVEL.

2. Adjust RECEIVE LEVEL range switch and vernier to obtain a meter reading of exactly 0 dB (black scale).

3. Set PULSE PERIOD switch at AUTO and observe meter readings as the test set cycles from pulse period 11 to 4. Record (for each pulse period) the meter deviation from the 0 dB reference set in step 2. (The cycling will pause at each pulse period for about 5 seconds. If cycling is too fast for record keeping, the cycling can be held at any pulse period by moving the PULSE PERIOD switch to HOLD.)

NOTE

Because of variations between repeater types, absolute criteria cannot be set for evaluating merit test results. However, some general guidelines are applicable. Typical repeaters will not normally show deviations greater than + 0.7 dB or − 0.4 dB between any two steps from 11 to 5. Deviation between pulse period 5 and 4 may be slightly greater, typically about + 1.0 dB or − 0.5 dB. In general, the most satisfactory operation is obtained from a repeater which best handles (has smallest deviations) the lower pulse period numbers. See Figure 4−13 for an example of partial data.

4.81 Line Repeater Side 2 Testing

4.82 If side 1 has been tested using the above procedure, side 2 can be tested by repeating the procedure. Simply set the REPEATER TEST switch at 1 CABLE/SIDE 2 or 2 CABLE/SIDE 2 (as appropriate) then return to the pulses, errors, and oscillations test of paragraph 4.76.

4.83 WECO 206/NE-206 NON-BRIDGING OFFICE REPEATER TEST PROCEDURE

4.84 The procedure in paragraphs 4.85 through 4.92 exercises and tests the receive section of non-bridging type 206 office repeaters. The non-bridging types include 206 repeaters with all letter codes **except** 206C. (The 206C is a bridging type and must be tested using the procedure of paragraph 4.93.)

4.85 Non-Bridging 206 Repeater Test Set Up

1. Make sure the test set is turned off.

2. Obtain a 7040-54 repeater adapter, insert the adapter's plug-in probe into the 7040 test well, and secure the adapter to the left side of the 7040 case (Figure 4−14).

3. Place BRID/NON-BRID switch on the adapter at NON-BRID.

4. On the repeater to be tested, tighten down powering option screws D and K. Make sure all other powering option screws are **not** tightened down.

5. Refer to Table 4—5 and make sure the repeater has a proper LBO network installed (if required).

6. Plug repeater into the 7040-54 adapter.

7. Make sure all test set front panel jacks are unplugged (empty).

8. Plug test set power cord into 115 V ac, 60 Hz power but do **not** turn on yet.

9. Make the following initial control settings:

   a. SYSTEM switch at T1,

   b. REPEATER TEST switch at 1 CABLE/SIDE 1,

   c. INTERFERENCE MARGIN switch at OFF,

   d. PULSE PERIOD switch at REF, and

   e. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS.

10. Proceed to the powering current/voltage check of paragraph 4.86 which follows.

Table 4—5. Type 206 Repeater LBO Requirements.

206 REPEATER CODES	LBO NETWORK CODE REQUIRED
A, B, D	A
E, F, G	C
H, J, K, L, M	none
N and up	(repeaters are ALBO design)

4.86 **Non-Bridging 206 Repeater Powering Current/Voltage Check**

1. Turn 7040 CURRENT ADJ control fully counterclockwise (CCW).

2. Set 7040 function switch at CURRENT.

3. From manufacturer's data or other records, determine the repeater's proper operating current.

4. Set POWER/LAMP TEST switch at POWER ON. This energizes the test set.

5. Turn CURRENT ADJ control to obtain proper repeater operating current reading on the meter.

6. Place function switch at VOLTAGE. The meter now shows voltage drop across the repeater. The voltage should be within tolerances specified by the repeater manufacturer.

7. Proceed to the leakage check of paragraph 4.87 which follows.

4.87 **Non-Bridging 206 Repeater HV Leakage Check**

1. Press and hold the HV LEAKAGE pushbutton.

2. Indicator lamp inside the pushbutton should **not** light. If it does light, there is excessive leakage between the repeater's powering leads and the repeater case.

3. Release the button and proceed to the pulses, errors, and oscillations test of paragraph 4.88 which follows.

4.88 **Non-Bridging 206 Repeater Pulses, Errors, and Oscillations Test**

1. Verify that the 7040 controls are set as follows:

   a. INTERFERENCE MARGIN switch at OFF,

   b. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS, and

   c. PULSE PERIOD switch at REF.

2. Set LINE LOSS switch at 31 dB.

3. Set 7040 function switch at QRSS.

4. If the repeater is operating correctly, the following indications should be observed:

   a. PULSES indicator flashing rapidly,

   b. OSC indicator off, and

   c. ERRORS indicator off.

NOTE

If PULSES indicator is not flashing (or is flashing intermittently), the repeater is not properly handling the test signal. If OSC indicator **only** is flashing, the repeater output contains nominal 10-kHz oscillations. If **both** PULSES and OSC indicators are flashing, All 1's oscillation is indicated. If ERRORS indicator is flashing, the repeater is producing bipolar violations.

5. Set function switch at XMT ERRORS.

6. If repeater is operating correctly, the following indications should be observed:

a. PULSES indicator flashing rapidly,

b. OSC indicator off, and

c. ERRORS indicator flashing slowly.

7. Return function switch to QRSS position.

8. Place VIOLATIONS/LOGICAL (QRSS) switch at LOGICAL (QRSS).

9. Place SYSTEM switch to T1, T1C, or T148C.

10. If repeater is operating correctly, the following indications should be observed:

a. PULSES indicator flashing rapidly,

b. OSC indicator off, and

c. ERRORS indicator off.

NOTE

If ERRORS indicator flashes, the repeater is creating logical bit errors as it handles the QRSS signal. If repeater displayed violation errors in step 4 above, then the logical error check will also show errors.

NOTE

If desired to check repeater operation over specified powering current range, set function switch to CURRENT and rotate ADJ control to obtain meter current indication between manufacturer's specified limits. Return current to nominal level specified and continue with the test.

11. Return VIOLATIONS/LOGICAL (QRSS) switch to VIOLATIONS.

12. Proceed to the dynamic range test of paragraph 4.89 which follows.

4.89 Non-Bridging 206 Repeater Input Dynamic Range Test

1. Rotate LINE LOSS switch slowly clockwise and counterclockwise to determine the switch settings at which the ERRORS indicator just starts to flash. Refer to manufacturer's specifications for the acceptable LINE LOSS range of repeater under test.

NOTE

A typical LINE LOSS range for LBO repeaters (with Code A LBO networks installed) is 24 to 36 dB. ALBO repeaters typically operate over a LINE LOSS range of 5 to 36 dB.

2. Proceed to the interference margin test of paragraph 4.90 which follows.

4.90 Non-Bridging 206 Repeater Interference Margin Test

1. Set LINE LOSS switch at 31 dB.

2. Rotate INTERFERENCE MARGIN switch slowly clockwise until ERRORS indicator just starts to flash. The INTERFERENCE MARGIN switch setting at this point represents the interfering signal margin (signal-to-noise ratio) capability of the repeater under test. Refer to manufacturer's wideband signal-to-noise ratio specifications for the repeater to determine if requirements are being met.

NOTE

For many repeater models, the acceptable interference margin will lie between 12 and 8.

3. Return the INTERFERENCE MARGIN switch to OFF.

4. Proceed to the fault locate output and positive/negative pulse balance test of paragraph 4.91 which follows.

4.91 Non-Bridging 206 Repeater Fault Locate Output and Pos/Neg Pulse Regeneration Balance Test

1. Set 7040 controls as follows:

a. LINE FILTER switch at F,

b. FAULT LINE switch at LEVEL, and

c. RECEIVE LEVEL vernier fully clockwise at CAL.

2. Verify that other controls are still set as follows:

a. LINE LOSS switch at 31 dB,

b. INTERFERENCE MARGIN switch at OFF, and

c. PULSE PERIOD switch at REF.

3. Set function switch at MEAS 1.

NOTE

When using MEAS 1, 2, or 3 test signals, the ERRORS indicator is flashing. This is normal.

4. Set RECEIVE LEVEL range switch for an on-scale meter reading. Note the reading in dBm (black scales) and refer to manufacturer's specifications for acceptable performance.

NOTE

For many repeaters, the acceptable fault locate signal output under these test conditions is − 75 ± 5 dBm.

5. Set RECEIVE LEVEL range switch **and** vernier to obtain a meter reading of exactly 0 dB (black scale).

NOTE

When using MEAS 1, 2, or 3 test signals, the ERRORS indicator is flashing. This is normal.

6. Move function switch to MEAS 2. Meter reading should drop by 6 ± 1 dB. Remember reading for next step.

7. Move function switch to MEAS 3. Meter should read within ± 1 dB of step 6.

8. Return function switch to MEAS 1.

9. If repeater is an LBO type, proceed to step 10. If repeater is an ALBO type, repeat steps 3 through 7 at LINE LOSS switch settings of 9 and 16 dB. Then return LINE LOSS switch to 31 dB and proceed to step 10.

10. Proceed to the merit test of paragraph 4.92 which follows.

4.92 **Non-Bridging 206 Repeater Merit Test**

1. Verify that controls are in the following positions:

   a. Function switch at MEAS 1,

   b. LINE FILTER switch at F,

   c. LINE LOSS switch at 31 dB,

   d. INTERFERENCE MARGIN switch at OFF,

   e. PULSE PERIOD switch at REF, and

   f. FAULT LINE switch at LEVEL.

NOTE

When using MEAS 1, 2, or 3 test signals, the ERRORS indicator is flashing. This is normal.

2. Adjust RECEIVE LEVEL range switch and vernier to obtain a meter reading of exactly 0 dB (black scale).

3. Set PULSE PERIOD switch at AUTO and observe meter readings as the test set cycles from pulse period 11 to 4. Record (for each pulse period) the meter deviation from the 0-dB reference set in step 2. (The cycling will pause at each pulse period for about 2 seconds. If cycling is too fast for record keeping, the cycling can be held at any pulse period by moving the PULSE PERIOD switch to HOLD.)

NOTE

Because of variations between repeater types, absolute criteria cannot be set for evaluating merit test results. However, some general guidelines are applicable. Typical repeaters will not normally show deviations greater than + 0.7 dB or − 0.4 dB between any two steps from 11 to 5. Deviation between pulse period 5 and 4 may be slightly greater, typically about + 1.0 dB or − 0.5 dB. In general, the most satisfactory operation is obtained from a repeater which best handles (has smallest deviations) the lower pulse period numbers.

4. This completes the test.

4.93 WECO 206C/NE-206C/QRY11A BRIDGING OFFICE REPEATER TEST PROCEDURE

4.94 The procedure in paragraphs 4.95 through 4.99 exercises and tests the receive section of WECO 206C, NE-206C, and QRY11A bridging office repeaters.

4.95 **Bridging 206C/QRY11A Repeater Test Set Up**

1. Make sure the test set is turned off.

2. Obtain a 7040-54 repeater adapter, insert the adapter's plug-in probe into the 7040 test well, then secure the adapter to the left side of the 7040 case (see Figure 4−14).

3. Place BRID/NON-BRID switch on the adapter at BRID.

NOTE

If the repeater is a 206C type with powering option screws, tighten down screws D and K . . . loosen all others.

4. Plug repeater into the 7040-54 adapter.

5. Make sure that all test set front panel jacks are unplugged (empty).

6. Make the following initial control settings:

   a. SYSTEM switch at T1,

   b. REPEATER TEST switch at 1 CABLE/SIDE 1,

   c. INTERFERENCE MARGIN switch at OFF,

   d. PULSE PERIOD switch at REF, and

   e. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS.

7. Place test set POWER/LAMP TEST switch at POWER ON.

NOTE

The test set automatically supplies correct operating voltage and current to the bridging repeater. These conditions are **not** measurable on the test set meter. If the function switch is at CURRENT, the meter will read zero. This is normal. If the function switch is at VOLTAGE, the meter will read over 22 volts. This is also normal.

8. Proceed to the HV leakage test of paragraph 4.96 which follows.

4.96 Bridging 206C/QRY11A Repeater HV Leakage Check

1. Press and hold the HV LEAKAGE pushbutton.

2. Indicator lamp inside the pushbutton should **not** light. If it does light, there is excessive leakage between the repeater's powering leads and the repeater case.

3. Release the button and proceed to the pulses, errors, and oscillations test of paragraph 4.97 which follows.

4.97 Bridging 206C/QRY11A Repeater Pulses, Errors, and Oscillations Test

1. Verify that the 7040 controls are set as follows:

   a. INTERFERENCE MARGIN switch at OFF,

   b. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS, and

   c. PULSE PERIOD switch at REF.

2. Set LINE LOSS switch at 9 dB.

3. Set function switch at QRSS.

4. If the repeater is operating correctly, the following indications should be observed:

   a. PULSES indicator flashing rapidly,

   b. OSC indicator off, and

   c. ERRORS indicator off.

NOTE

If PULSES indicator is not flashing (or is flashing intermittently), the repeater is not properly handling the test signal. If OSC indicator is flashing, the repeater output contains nominal 10-kHz oscillations. If **both** the PULSES and OSC indicators are flashing, All 1's oscillation is indicated. If ERRORS indicator is flashing, the repeater is producing bipolar violations.

5. Set function switch at XMT ERRORS.

6. If repeater is operating correctly, the following indications should be observed:

   a. PULSES indicator flashing rapidly,

   b. OSC indicator off, and

   c. ERRORS indicator flashing slowly.

7. Return function switch to QRSS position.

8. Place VIOLATIONS/LOGICAL (QRSS) switch at LOGICAL (QRSS).

9. Place SYSTEM switch to T1, T1C, or T148C.

10. If repeater is operating correctly, the following indications should be observed:

   a. PULSES indicator flashing rapidly,

   b. OSC indicator off, and

   c. ERRORS indicator off.

NOTE

If ERRORS indicator flashes, the repeater is creating logical bit errors as it handles the QRSS signal. If repeater displayed violation errors in step 4 above then the logical error check will also show errors.

11. Return VIOLATIONS/LOGICAL (QRSS) switch to VIOLATIONS.

12. Proceed to the dynamic range test of paragraph 4.98 which follows.

4.98 Bridging 206C/QRY11A Repeater Input Dynamic Range Test

1. Rotate LINE LOSS switch slowly clockwise and counterclockwise to determine the switch settings at which the ERRORS indicator just starts to flash. Refer to manufacturer's specifications for the acceptable LINE LOSS range of repeater under test.

NOTE

A typical LINE LOSS range for bridging repeater is 5 to 9 dB.

2. Proceed to the interference margin test of paragraph 4.99 which follows.

4.99 **Bridging 206C/QRY11A Repeater Interference Margin Test**

1. Set LINE LOSS switch at 9 dB.

2. Rotate INTERFERENCE MARGIN switch slowly clockwise until ERRORS indicator just starts to flash. The INTERFERENCE MARGIN switch setting at this point represents the interfering signal margin (signal-to-noise ratio) capability of the repeater under test. Refer to manufacturer's wideband signal-to-noise ratio specifications for the repeater to determine if requirements are being met.

NOTE

For typical repeater models, the acceptable interference margin will lie between 12 and 8 dB.

3. Return the INTERFERENCE MARGIN switch to OFF.

4. This completes the test.

4.100 QRY9A/QRY10A NON-BRIDGING OFFICE REPEATER TEST PROCEDURE

4.101 The procedure in paragraphs 4.102 through 4.109 exercises and tests the receive section of non-bridging QRY9A and QRY10A office repeaters.

4.102 **QRY9A/QRY10A Repeater Test Set Up**

1. Make sure the test set is turned off.

2. Obtain a 7040-54 repeater adapter, insert the adapter's plug-in probe into the 7040 test well, then secure the adapter to the left side of the 7040 case (see Figure 4—14).

3. Place the BRID/NON-BRID switch on the adapter at NON-BRID.

4. On the repeater to be tested, insert the uninsulated end of shorting pins into option switches SA(4) and SC(2). Make sure the insulated ends of shorting pins are installed in all other option switch positions.

5. Plug the repeater into the 7040-54 adapter.

6. Make sure all test set front panel jacks are unplugged (empty).

7. Plug test set power cord into 115 V ac, 60 Hz power but do **not** turn on yet.

8. Make the following initial control settings:

   a. SYSTEM switch at T1,

   b. REPEATER TEST switch at 1 CABLE/SIDE 1,

   c. INTERFERENCE MARGIN switch at OFF,

   d. PULSE PERIOD switch at REF, and

   e. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS.

9. Proceed to the powering current/voltage check of paragraph 4.103 which follows.

4.103 **QRY9A/QRY10A Repeater Powering Current/Voltage Check**

1. Turn 7040 CURRENT ADJ control fully counterclockwise (CCW).

2. Set 7040 function switch at CURRENT.

3. From manufacturer's data or other records, determine the repeater's proper operating current.

4. Set POWER/LAMP TEST switch at POWER ON. This energizes the test set.

5. Turn CURRENT ADJ control to obtain proper repeater operating current reading on the meter.

6. Place function switch at VOLTAGE. The meter now shows voltage drop across the repeater. The voltage should be within tolerances specified by the repeater manufacturer.

7. Proceed to the leakage check of paragraph 4.104 which follows.

4.104 **QRY9A/QRY10A Repeater HV Leakage Check**

1. Press and hold the HV LEAKAGE pushbutton.

2. Indicator lamp inside the pushbutton should **not** light. If it does light, there is excessive leakage between the repeater's powering leads and the repeater case.

3. Release the button and proceed to the pulses, errors, and oscillations test of paragraph 4.105 which follows.

4.105 **QRY9A/QRY10A Repeater Pulses, Errors, and Oscillations Test**

1. Verify that the 7040 controls are set as follows:

   a. INTERFERENCE MARGIN switch at OFF,

   b. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS, and

   c. PULSE PERIOD switch at REF.

2. Set LINE LOSS switch at 31 dB.

3. Set function switch at QRSS.

4. If the repeater is operating correctly, the following indications should be observed:

a. PULSES indicator flashing rapidly,

b. OSC indicator off,

c. ERRORS indicator off, and

d. Repeater's own ERRORS indicator off.

NOTE

If PULSES indicator is not flashing (or is flashing intermittently), the repeater is not properly handling the test signal. If OSC indicator is flashing, the repeater output contains nominal 10-kHz oscillations. If **both** PULSES and OSC indicators are flashing, All 1's oscillation is indicated. If ERRORS indicator is flashing, the repeater is producing bipolar violations.

5. Set function switch at XMT ERRORS.

6. If repeater is operating correctly, the following indications should be observed:

a. PULSES indicator flashing rapidly,

b. OSC indicator off,

c. ERRORS indicator flashing slowly, and

d. Repeater's own ERRORS indicator flashing slowly.

7. Return function switch to QRSS position.

8. Place VIOLATIONS/LOGICAL (QRSS) switch at LOGICAL (QRSS).

9. Place SYSTEM switch to T1, T1C, or T148C.

10. If repeater is operating correctly, the following indications should be observed:

a. PULSES indicator flashing rapidly,

b. OSC indicator off, and

c. ERRORS indicator off.

NOTE

If ERRORS indicator flashes, the repeater is creating logical bit errors as it handles the QRSS signal. If repeater displayed violation errors in step 4 above, then the logical error check will also show errors.

11. Return VIOLATIONS/LOGICAL (QRSS) switch to VIOLATIONS.

12. Proceed to the dynamic range test of paragraph 4.106 which follows.

4.106 QRY9A/QRY10A Repeater Input Dynamic Range Test

1. Rotate LINE LOSS switch slowly clockwise and counterclockwise to determine the switch settings at which the ERRORS indicator just starts to flash. Refer to manufacturer's specifications for the acceptable LINE LOSS range of repeater under test.

NOTE

A typical LINE LOSS is 5 to 36 dB.

2. Proceed to the interference margin test of paragraph 4.107 which follows.

4.107 QRY9A/QRY10A Repeater Interference Margin Test

1. Set LINE LOSS switch at 31 dB.

2. With function switch in QRSS position, rotate INTERFERENCE MARGIN switch slowly clockwise until ERRORS indicator just starts to flash. The INTERFERENCE MARGIN switch setting at this point represents the interfering signal margin (signal-to-noise ratio) capability of the repeater under test. Refer to manufacturer's specifications for the repeater to determine if requirements are being met.

NOTE

For many repeater models the acceptable interference margin will lie between 12 and 8 dB.

3. Return the INTERFERENCE MARGIN switch to OFF.

4. Proceed to the fault locate output and positive/negative pulse balance test of paragraph 4.108 which follows.

4.108 QRY9A/QRY10A Fault Locate Output and Pos/Neg Pulse Regeneration Balance Test

1. Set 7040 controls as follows:

a. LINE FILTER switch at F,

b. FAULT LINE switch at LEVEL, and

c. RECEIVE LEVEL vernier fully clockwise at CAL.

2. Verify that other controls are still set as follows:

   a. LINE LOSS switch at 31 dB,

   b. INTERFERENCE MARGIN switch at OFF, and

   c. PULSE PERIOD switch at REF.

3. Set function switch to MEAS 1.

NOTE

ERRORS indicators on test set and repeater light when MEAS 1, 2, or 3 signals are used. This is normal.

4. Set RECEIVE LEVEL range switch (normally − 70) for an on-scale meter reading. Note the reading in dBm (black scales) and refer to manufacturer's specifications for acceptable performance.

NOTE

For many repeaters, the acceptable fault locate signal output under these test conditions is − 75 ± 5 dBm.

5. Set RECEIVE LEVEL range switch **and** vernier to obtain a meter reading of exactly 0 dB (black scale).

NOTE

When using MEAS 1, 2, or 3 test signals the ERRORS INDICATOR is lighted. This is normal.

6. Move function switch to MEAS 2. Meter reading should drop by 6 ± 1 dB. Remember reading for next step.

7. Move function switch to MEAS 3. Meter should read within ± 1 dB of step 6.

8. Return function switch to MEAS 1.

9. Repeat steps 3 through 7 at LINE LOSS switch settings of 9 and 16 dB. Then return LINE LOSS switch to 31 dB and proceed to the merit test of paragraph 4.109 which follows.

4.109 QRY9A/QRY10A Repeater Merit Test

1. Verify that controls are in the following positions:

   a. Function switch at MEAS 1,

   b. LINE FILTER switch at F,

   c. LINE LOSS switch at 31 dB,

   d. INTERFERENCE MARGIN switch at OFF,

   e. PULSE PERIOD switch at REF, and

   f. FAULT LINE switch at LEVEL.

NOTE

ERRORS indicators on test set and repeater light when MEAS 1, 2, or 3 signals are used. This is normal.

2. Adjust RECEIVE LEVEL range switch and vernier to obtain a meter reading of exactly 0 dB (black scale).

3. Set PULSE PERIOD switch at AUTO and observe meter readings as the test set cycles from pulse period 11 to 4. Record (for each pulse period) the meter deviation from the 0-dB reference set in step 2. (The cycling will pause at each pulse period for about five seconds. If cycling is too fast for record keeping, the cycling can be held at any pulse period by moving the PULSE PERIOD switch to HOLD.)

NOTE

Because of variations between repeater types, absolute criteria cannot be set for evaluating merit test results. However, some general guidelines are applicable. Typical repeaters will not normally show deviations greater than + 0.7 dB or − 0.4 dB between any two steps from 11 to 5. Deviation between pulse period 5 and 4 may be slightly greater, typically about + 1.0 dB or − 0.5 dB. In general, the most satisfactory operation is obtained from a repeater which best handles (has smallest deviations) the lower pulse period numbers.

4. This completes the test.

4.110 QRY6A/QRY7A/QRY8A REPEATER TEST PROCEDURE

4.111 The procedure in paragraphs 4.113 through 4.118 exercises and tests the receive section of QRY6A, QRY7A, and QRY8A office repeaters. The test set does not supply operating power to these repeaters. Operating power must be supplied to the repeaters from an external − 48 V dc source (1A max) via a tip-sleeve cord equipped with 310 plug. The cord is part of the 7040-58 repeater test adapter.

4.112 The QRY6A is a line powering office repeater. The test adapter has a 300 Ω ± 1 % power resistor connected across V + OUT and V − OUT (pins 2 and 3) to provide a load.

4.113 **QRY6A/7A/8A Repeater Test Set Up**

1. Make sure the test set is turned off.

2. Obtain a 7040-58 repeater adapter, insert the adapter's plug-in probe into the 7040 test well, then secure the adapter to the left side of the 7040 case (see Figure 4—14).

3. For a QRY6A repeater, program the shorting pins of the option switches as follows:

   a. Insert uninsulated end into SA(1) and insulated end into SA(2),

   b. Insert insulated ends into SE(1) and SE(2) and uninsulated ends into SE(3) and SE(4),

   c. Insert insulated ends into SD(1) and SD(2), and

   d. Select either the 7.5 or 3.0 dB pad. For a 7.5 dB pad, insert uninsulated ends into SC(1), SC(2), and SC(3) and insulated ends into SB(1), SB(2), and SB(3). For a 3.0 dB pad, insert uninsulated ends into SB(1), SB(2), and SB(3) and insulated ends into SC(1), SC(2), and SC(3).

4. For a QRY7A repeater, program the shorting pins of the option switches as follows:

   a. Insert uninsulated end into SA(1) and insulated end into SA(2),

   b. Insert insulated ends into SE(1) and SE(2),

   c. Insert insulated ends into SD(1) and SD(2), and

   d. Select either the 7.5 or 3.0 dB pad. For a 7.5 dB pad, insert uninsulated ends into SC(1), SC(2), and SC(3) and insulated ends into SB(1), SB(2), and SB(3). For 3.0 dB pad, insert uninsulated ends into SB(1), SB(2), and SB(3) and insulated ends into SC(1), SC(2), and SC(3).

5. For a QRY8A repeater, insert uninsulated end of program pin into SA(1).

NOTE

If present, option switch positions SE(1) and SE(2) **must** have insulated pins (open circuit). If these two positions are inadvertently closed (shorted), then — 130 V dc will be shorted to ground for protection of the test set.

6. Plug the repeater into the 7040-58 adapter.

7. Make sure that all test set front panel jacks are unplugged (empty).

8. Make the following initial control settings:

   a. SYSTEM switch at T1,

   b. REPEATER TEST switch at 1 CABLE/SIDE 1,

   c. INTERFERENCE MARGIN switch at OFF,

   d. PULSE PERIOD switch at REF,

   e. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS, and

   f. Function switch at MEAS 1.

9. Make sure the test set is connected to a source of 115 V ac, 60 Hz power.

10. Place the test set POWER/LAMP TEST switch at POWER ON.

WARNING

The QRY6A repeater type has a line powering supply which contains potentially lethal voltages. Do not energize this repeater type unless it is fully inserted into the 7040-58 adapter and the adapter is firmly secured to the left side of the test set case.

11. Energize the repeater under test by connecting external — 48 V dc office battery to the 7040-58 adapter. A tip-sleeve cord with 310 plug capable of handling up to 1 ampere of current is provided for this purpose. Tip is — 48 V dc and sleeve and ring are ground.

NOTE

Since QRY6A, QRY7A, and QRY8A repeaters are powered from an external source, the powering voltage and current conditions are **not** measurable on the test set meter. If the test set function switch is at CURRENT, the meter will read zero. This is normal. If the function switch is at VOLTAGE, the meter will read over 22 V dc. This is also normal.

12. Continue testing according to type of repeater as follows:

   a. If repeater is a QRY6A, note that ERRORS indicator is lighted then proceed to step 13 below,

   b. If repeater is a QRY7A, note that ERRORS indicator is lighted, omit step 13 below and proceed to the pulses, errors, and oscillations check of paragraph 4.114, or

   c. If repeater is QRY8A, omit step 13 below and proceed to the pulses, errors, and oscillations check of paragraph 4.114.

13. For QRY6A repeaters only, use an external meter to measure the voltages present at + V, − V, and − 1 test points on the repeater's front panel. (Reference the measurements to GND on the front panel.) The + V measurement should be + 130 V dc maximum. The − V measurement should be − 130 V dc maximum. The − 1 voltage should be 1 ± 0.1 volt lower than the + V measurement. Proceed to the pulses, errors, and oscillations check of paragraph 4.114 which follows.

4.114 QRY6A/7A/8A Pulses, Errors, and Oscillations Test

1. Verify that the 7040 controls are set as follows:

   a. INTERFERENCE MARGIN switch at OFF,

   b. VIOLATIONS/LOGICAL (QRSS) switch at VIOLATIONS, and

   c. PULSE PERIOD switch at REF.

2. Set LINE LOSS switch at 24 dB for QRY6A/7A repeaters and 5 dB for QRY8A repeaters.

NOTE

For QRY6A/7A repeaters, the actual line loss is 27 dB when the 3 dB pad option is used and 31.5 dB when the 7.5 dB pad option is used.

3. Set function switch at QRSS.

4. If the repeater is operating correctly, the following indications should be observed:

   a. PULSES indicator flashing rapidly,

   b. OSC indicator off, and

   c. ERRORS indicator off.

NOTE

If PULSES indicator is not flashing (or is flashing intermittently), the repeater is not properly handling the test signal. If OSC indicator is flashing, the repeater output contains nominal 10 kHz oscillations. If **both** PULSES and OSC indicators are flashing, All 1's oscillation is indicated. If ERRORS indicator is flashing, the repeater is producing bipolar violations.

5. Set function switch at XMT ERRORS.

6. If repeater is operating correctly, the following indications should be observed:

   a. PULSES indicator flashing rapidly,

   b. OSC indicator off, and

   c. ERRORS indicator flashing slowly.

7. Return function switch to QRSS position.

8. Place VIOLATIONS/LOGICAL (QRSS) switch at LOGICAL (QRSS).

9. Place SYSTEM switch to T1, T1C, or T148C.

10. If repeater is operating correctly, the following indications should be observed:

   a. PULSES indicator flashing rapidly,

   b. OSC indicator off, and

   c. ERRORS indicator off.

NOTE

If ERRORS indicator flashes, the repeater is creating logical bit errors as it handles the QRSS signal. If repeater displayed violation errors in step 4 above, then the logical error check will also show errors.

11. Return VIOLATIONS/LOGICAL (QRSS) switch to VIOLATIONS.

12. Proceed to the dynamic range test of paragraph 4.115 which follows.

4.115 QRY6A/7A/8A Input Dynamic Range Test

1. With function switch in QRSS position, rotate LINE LOSS switch slowly clockwise and counterclockwise to determine the switch settings at which the ERRORS indicator just starts to flash. Refer to manufacturer's specifications for the acceptable LINE LOSS range of repeater under test.

NOTE

A typical LINE LOSS range is 2 to 33 dB for QRY6A/7A repeaters that have 3 dB pads. For QRY8A repeaters the typical LINE LOSS range is 5 to 9 dB.

2. Proceed to the interference margin test of paragraph 4.116 which follows.

4.116 QRY6A/7A/8A Interference Margin Test

1. Set LINE LOSS switch at 24 dB for QRY6A/7A repeaters and at 5 dB for QRY8A repeaters.

NOTE

The actual line loss is 27 dB when the 3 dB pad option is used and 31.5 dB when the 7.5 dB pad option is used. This has no effect on this test.

2. With function switch in QRSS position, rotate INTERFERENCE MARGIN switch slowly clockwise until ERRORS indicator just starts to flash. The INTERFERENCE MARGIN switch setting at this point represents the interfering signal margin (signal-to-noise ratio) capability of the repeater under test. Refer to manufacturer's wideband signal-to-noise ratio specifications for the repeater to determine if requirements are being met.

NOTE

For many repeater models, the acceptable interference margin will lie between 12 and 8 dB.

3. Return the INTERFERENCE MARGIN switch to OFF.

4. Proceed to the fault locate output and positive/negative pulse balance test of paragraph 4.117 which follows.

4.117 QRY6A/7A Fault Locate Output and Pos/Neg Regeneration Balance Test

1. Set 7040 controls as follows:

   a. LINE FILTER switch at F,

   b. FAULT LINE switch at LEVEL, and

   c. RECEIVE LEVEL vernier fully clockwise at CAL.

2. Verify that other controls are still set as follows:

   a. LINE LOSS switch at 24 dB,

NOTE

The actual line loss is 27 dB when the 3 dB pad option is used and 31.5 dB when the 7.5 dB pad option is used. This has no effect on this test.

   b. INTERFERENCE MARGIN switch at OFF, and

   c. PULSE PERIOD switch at REF.

3. Set function switch at MEAS 1.

NOTE

When using MEAS 1, 2, or 3 test signals, the ERRORS indicator is flashing. This is normal.

4. Set RECEIVE LEVEL range switch (normally – 70) for an on-scale meter reading. Note the reading in dBm (black scales) and refer to manufacturer's specifications for acceptable performance.

NOTE

For many repeaters, the acceptable fault locate signal output under these test conditions is – 75 ± 5 dBm.

5. Set RECEIVE LEVEL range switch **and** vernier to obtain a meter reading of exactly 0 dB (black scale).

NOTE

When using MEAS 1, 2, or 3 test signals, the ERRORS indicator is flashing. This is normal.

6. Move funcion switch to MEAS 2. Meter reading should drop by 6 ± 1 dB. Remember reading for next step.

7. Move function switch to MEAS 3. Meter should read within ± 1 dB of step 6.

8. Return function switch to MEAS 1.

9. Repeat steps 3 through 7 at LINE LOSS of 5 and 9 dB. Then return LINE LOSS switch to 24 dB and proceed to the merit test of paragraph 4.118 which follows.

4.118 QRY6A/7A Repeater Merit Test

1. Verify that controls are in the following positions:

   a. Function switch at MEAS 1,

   b. LINE FILTER switch at F,

   c. LINE LOSS switch at 24 dB.

NOTE

When using MEAS 1, 2, or 3 test signals, the ERRORS indicator is flashing. This is normal.

NOTE

The actual line loss is 27 dB when the 3 dB pad option is used and 31.5 dB when the 7.5 dB pad option is used. This has no effect on this test.

   d. INTERFERENCE MARGIN switch at OFF,

   e. PULSE PERIOD switch at REF, and

   f. FAULT LINE switch at LEVEL.

2. Adjust RECEIVE LEVEL RANGE SWITCH **and** vernier to obtain a meter reading of exactly 0 dB (black scale).

3. Set PULSE PERIOD switch at AUTO and observe meter readings as the test set cycles from pulse period 11 to 4. Record (for each pulse period) the meter deviation from 0 dB reference set in step 2. (The cycling will pause at each pulse period for about 2 seconds. If cycling is too fast for record keeping, the cycling can be held at any pulse period by moving the PULSE PERIOD switch to HOLD.)

NOTE

Because of variations between repeater types, absolute criteria cannot be set for evaluating merit test results. However, some general guidelines are applicable. Typical repeaters will not normally show deviations greater than + 0.7 dB or − 0.4 dB between any two steps from 11 to 5. Deviation between pulse period 5 and 4 may be slightly greater, typically about + 1.0 dB or − 0.5 dB. In general, the most satisfactory operation is obtained from a repeater which best handles (has smallest deviations) the lower pulse period numbers.

4. This completes the test.

4.119 PCM FAULT LOCATING BACKGROUND

4.120 The following paragraphs present some detailed information concerning the basic fault locating scheme used on PCM span lines and the effect that the fault locating signal has on repeaters.

4.121 BASIC PCM FAULT LOCATING

4.122 Figure 4−15 shows a typical fault locating system on a PCM span line comprised of bidirectional (1-cable) repeaters. Each apparatus case has one assigned fault locating filter chosen from a set of 12 (A-M) that have mid-band frequencies ranging from 832 to 3017 Hz. For logical record keeping purposes, the filters are usually assigned in alphabetical order. However, this is not necessary for fault locating as long as there is a record of all filter assignments and locations. This scheme uses one filter for both directions of transmission. Thus each direction must be fault located separately and from different ends.

4.123 For unidirectional (2-cable) repeater apparatus cases, a separate filter is assigned for each direction of transmission. When more than 12 repeaters are used to make up a span line, two fault locating pairs are used, and each pair can have up to 12 filters (A-M).

4.124 Fault locating is accomplished by sending a specially-formatted signal supplied by the Model 7040 toward the direction of transmission. This signal contains an audio frequency component corresponding to one of the 12 filter frequencies (codes). Only the correspondingly-coded fault locating filter can pass that particular audio frequency to the fault locating pair. The signal is thus returned over the fault locating pair to the transmitting office, and is detected/measured by the fault locating receiver in the Model 7040.

4.125 Evaluation of the span line section under test is made by comparing the meter indication against a previously recorded reference level. This technique is repeated for each line section (filter section) in sequence, working in the direction of transmission until the bad line section is found. This is usually indicated by a significant drop in the meter reading. Total transmission failures are found in this way. The test is referred to as a fault locating PCM transmission test. The more difficult to detect, marginal, or obscure troubles are evaluated more critically by varying the pulse stream density as described in paragraph 4.133.

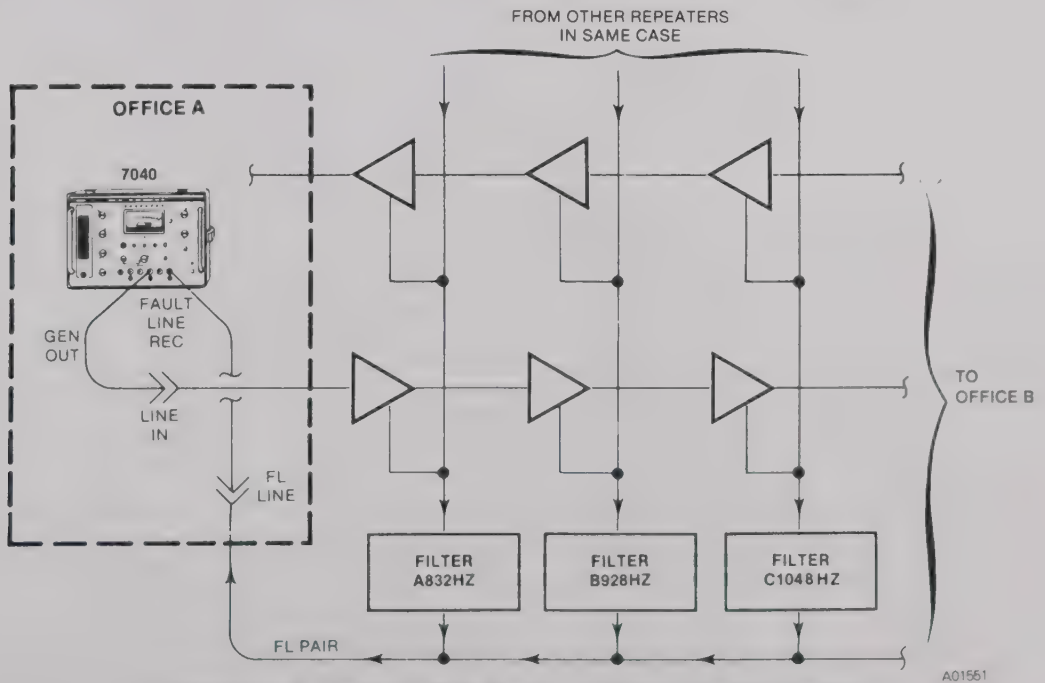

Figure 4−15. Typical PCM Span Line Fault Locating System.

4.126 THE FAULT LOCATING SIGNAL

4.127 Two important functions are performed by the fault locating signal: (1) it must uniquely identify the particular repeater under test from all other repeaters making up the span line and (2) it must stress the pulse regeneration decision-making circuits in repeaters on the line. Identification is a function of the audio component impressed onto the test signal and returned by the fault locating filter. Stress is a function of the fault locating signal pulse density.

4.128 The basic MEAS 1 fault locating signal shown in Figure 4—16 is composed of fundamental building blocks called pulse trios. A positive trio is made up of one positive unipolar pulse followed by a bipolar pair. Thus a positive trio has an excess of one positive unipolar pulse. The opposite is true for a negative trio. When a group of consecutive positive trios is followed by a group of negative trios, a basic fault locating signal is formed. It is referred to as MEAS 1. If the two groups are switched at the selected audio rate having a period of t, an audio component f = 1/t is present. The frequency can be recovered by the fault locating filter and measured by the fault locating test set. This pattern is designed to equally stress both regenerators in a repeater.

4.129 Stressing the regenerator circuits in a repeater relies on the fact that a group of either positive or negative trios has a dc component that is not zero. Figure 4—17 shows a typical schematic diagram of a basic positive pulse regenerator and associated circuits. Diodes CR1 and CR2, R1, and Q1 comprise the regenerator. Assuming that the forward voltage drop across CR1 is equal to the base-emitter drop of Q1, the decision voltage Vd at point A is 0 V dc. This voltage level is where Q1 will just start to conduct and is the **decision threshold** used to determine whether or not to regenerate a pulse. The decisions are made during the time that the clock is positive.

4.130 The negative peak detector generates a negative voltage − Vc that is equal to approximately one-half of the long-term average peak amplitude at the preamplifier output. This negative voltage is applied to both regenerators through the secondary windings of T1. Since the normal bipolar signal has no dc component, its baseline floats about − Vc which is assumed to be − 1 V dc. This positions the positive peaks at + 1 V dc and the decision voltage Vd falls midway between the peaks and the baseline. Any interfering signal would have to exceed one-half the peak amplitude to cause either: (1) errors of commission (adding pulses where none existed) or (2) errors of omission (deleting pulses that did exist). This is the maximum interference margin that can be obtained with this circuit.

4.131 The second signal (B in Figure 4—17) is a portion of the MEAS 2 fault locating signal. Since it also is assumed to be 2 volts peak amplitude, − Vc is still − 1 V dc. The first portion of the signal has an excess of positive unipolar pulses and thus has a dc component that is assumed to be + 0.3 V dc. As the dc component must float on − Vc, the baseline has been shifted downward by 0.3 volt. This drops the positive peaks downward and moves them closer to Vd which is always fixed at 0 V dc. The end result is that the margin against errors of omission caused by an interfering signal riding on the top of the pulses has been decreased considerably.

4.132 An analysis of this same MEAS 2 signal at the negative regenerator would show that the baseline is shifted closer to the decision voltage Vd. This reduces the margin against errors of commission. Both types of errors tend to decrease the audio level returned to the fault locating test set. A MEAS 3 signal consisting of an excess of negative unipolar pulses affects the repeater's negative regenerator in the same manner.

4.133 The amount of baseline shift and the stress placed on the regenerators is directly proportional to the pulse density (inversely proportional to pulse period number). As shown in Figure 4—18A there is one unipolar pulse per 11 time slots for this MEAS 2, pulse period 11 signal. This is a signal of light density which causes very little baseline shift and places little stress on the regenerators. On the other hand, the pulse period 4 signal shown in Figure 4—18B is a very dense signal. It has one unipolar pulse per 4 time slots. This places the most stress on the regenerators that the fault locating signal can create.

4.134 As a fault locating signal is stepped from pulse period 11 to pulse period 4 the audio component increases. An amount of attenuation is introduced in the Model 7040 receiver to partially offset this increase. The overall result is a gradually-rising response versus pulse period. This prevents the masking out of small variations in the relative meter indication caused by errors created in the regenerators.

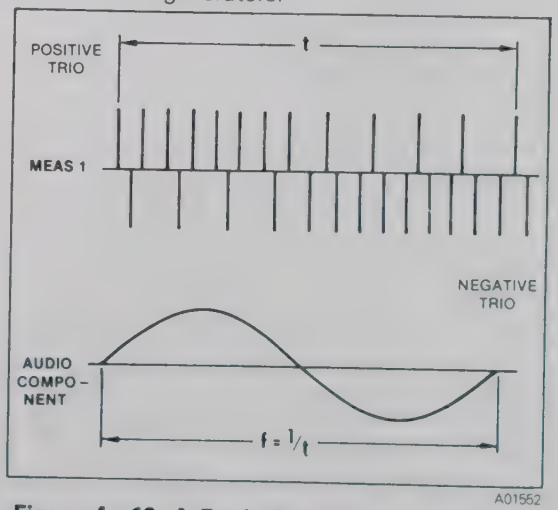

Figure 4—16. A Basic Fault Locating Signal.

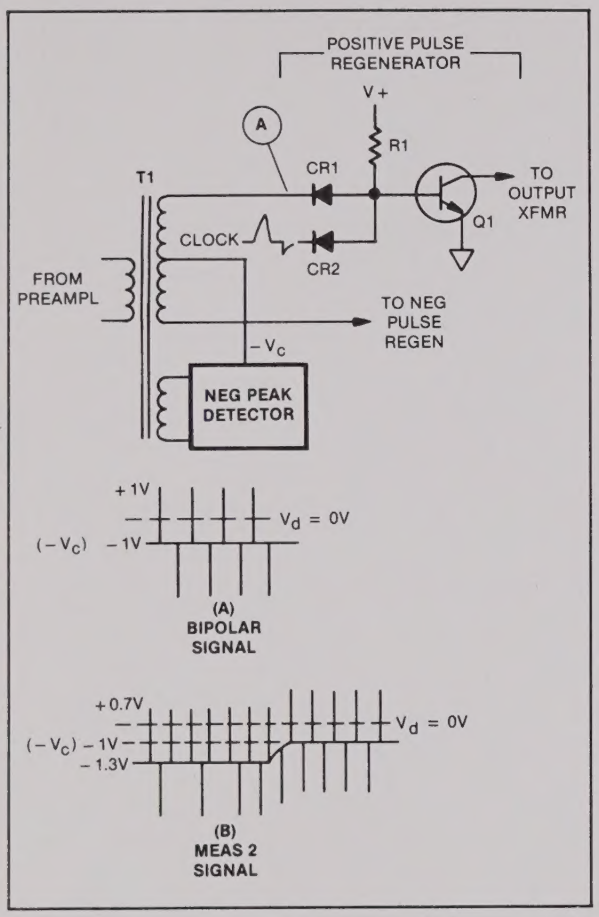

Figure 4—17. Stressing Pulse Regenerators of a Repeater.

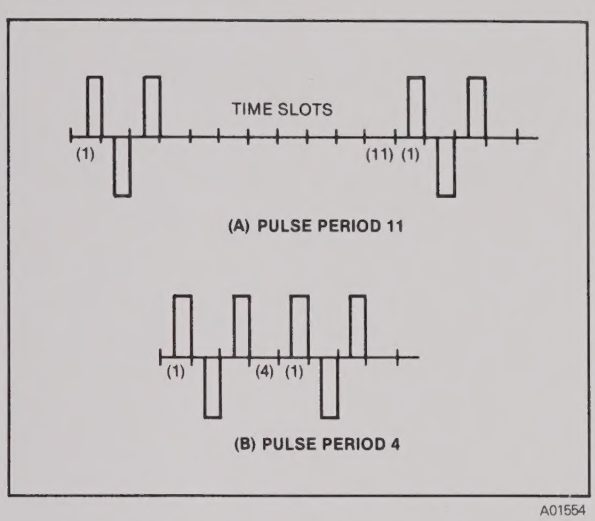

Figure 4—18. Pulse Density Versus Pulse Period.

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